Rungas
PRIME INDUSTRIES

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT (ESIA) REPORT FOR THE PROPOSED 400,000 UNITS PER ANNUM TYPE 3 COMPOSITE LPG CYLINDER MANUFACTURING PLANT AT POLAKU, BAYELSA STATE.

SUBMITTED TO:

FEDERAL MINISTRY OF ENVIRONMENT
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LIST OF ACRONYMS

FMENV	-	Federal Ministry of Environment
NESREA	-	National Environmental Standard & Regulation & Enforcement Agency
WHO	-	World Health Organisation
TOR	-	Terms of Reference
ANSI	-	American National Standards Institute
EIA	-	Environmental Impact Assessment
ESIA	-	Environmental & Social Impact Assessment
ELF	-	Extremely Low Frequency
ESMP	-	Environmental & Social Management Plan
IAP	-	Interested and Affected Party
PPP	-	Public Participation Process
THB	-	Total Hydrocarbon utilizing bacteria
THF	-	Total Hydrocarbon Fungi
HUB	-	Hydrocarbon Utilising Bacteria
HUF	-	Hydrocarbon Utilising Fungi
BHW	-	Borehole Water
TNTC	-	Too Numerous to Count
ND	-	Not Detected
COD	-	Chemical Oxygen Demand
BOD	-	Biochemical Oxygen Demand
OD	-	Oxygen Demand
TSS	-	Total Suspended Solid
TDS	-	Total Dissolved Solid
EMP	-	Environment Management Plan
FEPA	-	Federal Environmental Protection Agency
EA	-	Environmental Assessment
EAR	-	Environmental Audit Report
mg/L	-	Milligram per Litre
µS/cm	-	Micro Semen per Centimetre
^{o}C	-	Degree Centigrade
FNU	-	Formazin Nephelometric Units
CS	-	Control Sample
BH	-	Borehole
SW	-	Surface water
LPG	-	Liquidified Petroleum Gas
IFC	-	International Finance Corporation

EXECUTIVE SUMMARY

0.1. INTRODUCTION AND BACKGROUND

Nigeria has a population of 190 million based on the last population census. It is worthy to note that only 1.8 million people of the entire population currently use Liquefied Petroleum Gas (LPG) and there are over 3 million old and unsafe cylinders currently in circulation. The 2014 global market evaluation of LPG was about $236.8 billion and is expected to grow by over $41.2 billion during the period of 2019 - 2023. The LPG industry is worth over $10 billion and is still expanding due to the number of refineries that are coming on stream across Nigeria-this will increase the quantity of LPG in the market and will need to be supported by cylinder production and LPG facilities.

The Government is aiming to ensure that over 4 million homes within the next two years utilize LPG, being a cleaner fuel and aims at furthering this plan via investing and facilitating local gas cylinder manufacturing. In addition, the Government is looking at 100% of production of gas cylinders in the country within five years. To ensure the desired saturation of cylinders within Nigeria it is imperative that the scheme is backed by the Federal Government and NCDMB.

In furtherance of the Federal Government of Nigeria’s mission and goals, Rungas Prime Industries Limited is offering to build a composite LPG cylinder in Polaku Bayelsa. The mission of Rungas Prime Industries Limited is to provide increased accessibility through its product offerings of composite LPG cylinders and other advanced LPG infrastructures that are enhanced with state -of -the- art- technology. Through this project there will be a widespread of the distribution of LPG Type 3 Composite gas cylinders leading to an extensive use of LPG in almost all homes in Nigeria which will reduce the emission of greenhouse gases capable of causing environmental degradation.

In compliance with the Environmental Impact Assessment Act CAP E12 LFN 2004, and because the proposed project activities will have some interactive influences with the environment, there is need to conduct an Environmental & Social Impact Assessment studies.

0.2. THE PROJECT PROPONENT

The project proponent is Rungas Prime Industries Limited. Rungas Prime Industries Limited is a dynamic and integrated manufacturing company whose mission is to provide increased accessibility through its product offerings of composite LPG cylinders and other advanced LPG infrastructures that are enhanced with state-of-the-art technology to promote and ensure the widespread saturation and use of LPG (a cleaner fuel) in all homes and commercial establishments across the continent of Africa starting with Nigeria.

0.3. THE PROPOSED PROJECT LOCATION

The proposed project is in Polaku Community, Yenagoa Local Government Area, Bayelsa State. The site is accessed through the bitumen tarred Polaku-Igbogene road, while access is into the site is through untarred stone-base earth road. The project site share common boundary with the Taylor Creek.

0.4. TERMS OF REFERENCE (TOR)

The Terms of Reference (TOR) for this assessment is illustrated as followings:

- Existing vegetation or wildlife
- Other natural physical environment (air, water, soil), as well as principal physical features like topography, geology, drainage.
- Manmade physical environment along the corridor of the proposed project area e.g. buildings, cultural facilities, schools, hospitals, electricity poles/line, communication lines and such other public infrastructure.
- Human health and socio-economic of the communities along the corridors including culture.
- Aesthetic value of the environment.
- The study shall cover all aspects of preparatory and operational phases of the project; focusing on evolution and interpretation of environmental impacts of the project by carrying out the following.
- Generate baseline data of the existing ecology and socio economy of the proposed project areas.
- Identify, evaluate, prediction all impacts of the project on the environment including, health, security and safety.
- Development of a workable control and monitoring programmes and strategies to enhance the quality, beauty and aesthetics of the proposed project.
- Mitigation and amelioration of significant adverse impacts that the project shall have on the environment including traffic and human control.
- Development of environmental management systems including plans and procedures for effective management of the project at completion in terms of waste management (solid, liquid and air).
- Identify adverse action or inaction of project designers, engineers, monitors and the impacts of such actions on the project and the environment.
- Predicting potential impacts of all activities
- Recommendations on mitigating measures
- Monitoring, EMS and plan of action

- Submission of written report to the proponents and the authorities.
- Approval of the ESIA study report from the environmental authorities.

0.5. ESIA OBJECTIVES AND APPROACH

The basic objective of the ESIA study is to:

- collect baseline environmental samples for the proposed factory;
- assess, evaluate and predict the potential impacts of the field development project activities and their significance on the identified environmental sensitivities;
- review and update the baseline information of the area in line with the project scope;
- assess analysis of alternatives towards minimizing the environmental and social impacts and costs;
- assess and evaluate the requirements of environmental enhancement through ensuring proper consultation with the communities; and
- prepare Environment & Social Management Plan (ESMP) considering the input of public consultation, analysis of alternatives and impact assessment of the project.

0.6. ENVIRONMENTAL SCREENING AND SCOPING

Project screening of ESIA is the first step in the initial assessment of the possible environmental impacts of the proposed project. The purpose of the project screening is to ascertain if the proposed project requires an ESIA through the elimination of irrelevant environmental issues and focusing on potentially significant issues at the planning and design stages. The representatives of the Federal Ministry of Environment (FMENV) attended the site verification and scoping workshop. The scope of screening study included:

- consideration of bio-physical, socio-economic and health issues, environmental sensitive area and the relevant legislative framework; and,
- consultation with key decision-makers and experts to identify key issues.

0.7. ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PREMISES

- The key Environmental Impact Assessment (EIA) principles were established to provide general guidance, framework, and a commitment to standards, which are acceptable nationally and internationally. In line with this, the principles will be retained in this study and where necessary variations are allowed with evidence. Additional procedures, commitments and understanding necessary to resolve environmental impact, were developed and adopted through the Environmental Impact Assessment (EIA) process. The premises are as follows:

- Rungas Prime Industries Limited recognizes the Federal Ministry of Environment, and other State Environmental Regulatory Agencies and laws operating both nationally and internationally. Furthermore, the project will adopt the best option relevant to the local circumstances and situations.
- The project has been designed to comply with these local and national laws, in conjunction with all the international protocols, agreements and conventions.
- During this Environmental & Social Impact Assessment Study all the understandings arrived at during consultations with the Federal Ministry of Environment and the issues raised by the indigene during the stakeholder's process were without prejudiced considered.
- Consultations have and will continue to be held with all stakeholders at various levels (State and Local Governments) together with Polaku community. Consultation meetings shall be maintained on a mutually agreed basis during the entire project phases.
- During this ESIA an Environmental & Social Management Plan (ESMP) has been developed as part of the ESIA process. The implementation of the plan will be the responsibility of Rungas Prime Industries Limited.

0.8. LEGAL AND ADMINISTRATIVE FRAMEWORK

There are existing Federal /State statutory regulations requiring Development Permit for any new project and those that require the proponent of a major/mandatory project to submit an Environmental Implication study report prior to the execution. The Project area is subject to many other specific laws, guidelines and standards that ensure compliance with environmental pollution abatement in facilities that generate wastes, groundwater protection and surface impoundment, health and safety, and hazardous substances. Rungas Prime Industries Limited believes and adheres to the principle of sustainable development. The following are some of the international and national/local environmental regulations.

WORLD BANK GUIDELINES ON ENVIRONMENTAL ASSESSMENT (EA) 1991.

The World Bank has set up environmental assessment standards that must be fulfilled by any project proponent before they can access financial assistance in form of loan. In line with the foregoing, the World Bank requires an EIA report as a prerequisite for the borrower to be granted approval for such loans. The EIA report normally forms part of the feasibility study of the project. Projects are categorized based on their EIA requirements and is very much like that of FEPA. The details of World Bank's EIA procedures and guidelines are published in the Bank's EA Source Book vols. I - III of 1991. The potential issues considered are biodiversity, coastal and marine resources management, cultural properties, hazardous & toxic materials, and international waterways.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE & NATURAL RESOURCES (IUCN) GUIDELINES.

The World Conservation Union of Nature & natural Resources (IUCN) in conjunction with the oil Industry International Exploration and Production forum (E & P Forum) have guidelines, which contain internationally acceptable practices and standards for oil and gas exploration and production. These guidelines present practical measures to conserve wetlands and enhance protection of aquatic ecosystem during oil and gas E & P activities.

This regulation and its standards were also considered in preparing the environmental studies to ensure that the natural resources are conserved during construction and operations phases.

CONVENTION ON BIOLOGICAL DIVERSITY

The objectives of this Convention encompass the conservation of biological diversity, through the sustainable use of environmental components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

BASEL CONVENTION ON THE CONTROL OF TRANS-BOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL

The convention focuses attention on the hazards of the generation and disposal of hazardous wastes. The convention defines the wastes to be regulated and control their trans-boundary movement to protect human and environmental health against their adverse effects.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (1992)

Climate change is a global environmental issue and it therefore requires concerted efforts of all the nations. To achieve sustainable social and economic development, energy consumption in the developing nations needs to grow considering the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general. This also includes the application of new technologies on terms which make such an application economically and socially beneficial, determined to protect the climate system for present and future generations. The proposed project has incorporated strategies into its manufacturing technology and processes to improve energy consumption and to ensure efficiency.

LAND USE ACT CAP 202 LFN 1990

The Land Use Act was promulgated in 1978 with commencement date of March 29, 1978 now Land Use Act Cap 202 LFN 1990. It vests all land in each State of the Federation (except land already vested in the Federal Government of Nigeria 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 confers similar powers regarding non-urban areas on the local governments in such cases. The governor of a State can revoke a right of occupancy for overriding public interest (e.g. new project development purposes). The following surface rights are permitted under Section 51 of the Land Use Act fishing rights, buildings and other structures, juju shrines, objects of worship, farms, cultivated crops, economic trees, projects and Loss of use of the land.

FEDERAL MINISTRY OF ENVIRONMENT (FMENV)

The Federal Ministry of Environment is now the apex institution in Nigeria charged with the overall responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources. The Ministry grants permits for environmental and laboratory consultancies and must approve an Environmental Impact Assessment (EIA) study of a major development activity before the proponent can implement execution.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ACT. CAP E12, LFN 2004.

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

This process involves the undertaking of mandatory study by a review panel and the preparation of a mandatory Environmental Impact Assessment (EIA) report.

REGULATIONS GAZETTED AS SUPPLEMENTARY TO NESREA ACT

- National Environmental (Soil Erosion and Flood Control) Regulations, S. I. No. 12 of 2011
- National Environmental (Surface and Groundwater Quality Control) Regulations, S. I. No. 22 of 2011
- National Environmental (Protection of Wetlands, River Banks and Lake Shores) Regulations, S. I. No. 26 of 2009:
- National Environmental (Watershed, Mountainous, Hilly and Catchments Areas protection) Regulations, S. I. No. 27 of 2009

- National Environmental (Sanitation and Wastes Control) Regulations, S. I. No. 28 of 2009
- National Environmental (Noise Standards and Control) Regulations, S. I. No. 35 of 2009
- National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, S. I. No. 15 of 2011
- National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. No. 16 of 2011
- National Environmental (Construction Sector) Regulations, S. I. No. 19 of 2011

THE MINERAL OIL (SAFETY) ACT CAP 350 LFN 1990

This Act is promulgated to ensure that project proponents design methods to address the safety of employees in the oil & gas sector. Sections 37 and 40 of the Mineral Oil (Safety) Act CAP 350 LFN 1990 require provision of Personal Protective Equipment (PPE) and the safety measures for workers in drilling and production operation in accordance with international standards.

NATIONAL INLAND WATERWAYS AUTHORITY ACT NO 13 OF 1997

This Act established the National Inland Waterways Authority 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 erection of permanent structures within the right-of-way or diversion of water from a declared waterway.

FORESTRY LAW CAP 52, 1994

Conservation of the natural resources is key to sustainable development and to avoid extinction of some species of plants and animals; and it was pursuant to this that this law was promulgated. The Forestry law prohibits any act that may lead to the destruction of or cause injuries to any forest produce, forest growth or forest property. The law clearly states the administrative framework for the management, utilization and protection of forestry resources in Nigeria.

TERRITORIAL WATERS ACT CAP 428 LFN 1990

The territorial waters of Nigeria shall for all purpose include every part of the open sea within twelve nautical miles of the coast of Nigeria (measured from low water mark) or of the seaward limits of inland waters. Any act or omission which:

- is committed within the territorial waters in Nigeria, whether by a citizen of Nigeria or a foreigner; and
- would, if committed in any part of Nigeria, constitute an offence under the law in force in that part, shall be an offence under that law and the person who committed it may, subject to section 3 of this Act, be arrested, tried and punished for it as if he had committed it in that part of Nigeria

WATER RESOURCES ACT CAP W2 LFN 2004

The Water Resources Act vests the right to the use and control of all surface and groundwater and of all water together with the bed and banks in any watercourse affecting more than one state in the Government of the Federation. However, the Act essentially preserves existing rights, including customary rights, provided they are for domestic use, watering of livestock and personal irrigation schemes. A proviso to section 1(1) states that the subsection shall not be deemed to infringe or to constitute a compulsory right over or interest in property. Apparently, the idea is to separate rights over water resources from other rights in property.

THE DEPARTMENT OF PETROLEUM RESOURCES (DPR) ENVIRONMENTAL GUIDELINES & STANDARDS FOR PETROLEUM INDUSTRY IN NIGERIA 2018.

The Department of Petroleum Resources (DPR) Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) 2018 was enacted to regulate the Nigerian Petroleum Industry. It was made mandatory in Part viii (A) sections 1.4.3(ii) and 1.6 for project proponents to prepare Environmental Impact Assessment (EIA) reports for all developmental projects within the petroleum industry.

BAYELSA STATE MINISTRY OF ENVIRONMENT

The Edict setting up the Bayelsa State Ministry of Environment outlines the primary responsibilities of the ministry, which is to develop policies to protect and develop the general environment of Bayelsa State. The Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004 is the substantive law that regulates the establishment of projects that infringe on environmental elements in Nigeria, the State in which each project is located has a major role to play in the overall Environmental & Social Impact Assessment (ESIA) process as a matter of law. The projects which are outside the mandatory study under the EIA Act is captured in ESIA and monitored by FME.

0.9. SCOPE OF WORK

The scope of work for this ESIA involve an extensive literature survey and a comprehensive field data gathering exercise to effectively characterize the study area. Specifically, the work scope shall entail:

- Review of national and international environmental regulations guiding the composite LPG cylinder production activities to be carried out as well as consultation with relevant stakeholders.
- Description of the Project, baseline/data gathering and report writing.

0.10. STUDY APPROACH AND METHODOLOGY

The ESIA study has been undertaken in accordance with FMENV, World Bank and other Nigerian regulatory standards. The distinct phases of the study include: Literature review, project understanding and institutional consultation, site verification/scoping, collection of secondary information and monitoring, laboratory analysis of samples ably monitored by Representatives of FMENV and report writing.

0.11. EQUATOR PRINCIPLES (EPS) AND IFC PERFORMANCE STANDARDS

The Equator Principles (EPs) is a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. The EPs, based on the IFC Performance Standards on social and environmental sustainability and on the World Bank Group Environmental, Health, and Safety Guidelines (EHS Guidelines), are intended to serve as a common baseline and framework for the implementation by each Equator Principles Financial Institutions (EPFI). These principles were applied in this study.

0.12. IFC PERFORMANCE STANDARDS

International Finance Corporation (IFC) Performance Standards defines clients' roles and responsibilities for managing projects and the requirements for receiving and retaining financing from EPFI's. The proposed project was benchmarked against the IFC performance standards and the project location and underlining principles comply.

0.13. STRUCTURE OF THE ESIA REPORT

The structure of the ESIA report is as shown below:

- Chapter One – The chapter one contains the introduction; and it contains the background information, ESIA objectives, Legal/administrative framework, structure of the ESIA report.

- Chapter Two – This contains the Project Justification, and it emphasizes the proposed project background, project objectives, basis of the project, envisaged sustainability, and development options to be considered in the proposed project;
- Chapter Three- This chapter contains the project description, it describes the type of project, scope, location, material input/output and by-products, waste generation, technical layout and process, operation and maintenance, proposed project schedules;
- Chapter Four - Description of Existing Environment is contained in this chapter and it further provides every information on the precinct/baseline environmental conditions of the project area describing the physical, chemical, biological social, and health environment
- Chapter Five - Associated and Potential Environmental Impacts – emphasis is placed on the Associated and Potential Environmental Impacts of the proposed project;
- Chapter Six – Mitigation Measures/Alternatives – illustrates the mitigation options for the proposed project impacts;
- Chapter Seven - Environmental & Social Management Plan - presents the proposed plans for the social & environmental management;
- Chapter Eight - Decommissioning and Abandonment Plan defines the strategies to be adopted during decommissioning of the plant and provides remediation plans after decommissioning/abandonment.; and
- Chapter Nine - Conclusion and Recommendations

0.14 PROJECT JUSTIFICATION

The Federal Government has initiated national drive on Liquefied Petroleum Gas Expansion Implementation Plan, to increase the usage of LPG in Nigeria and also ensure that the facilities needed to facilitate the easy use of the cleaner fuel is readily and abundantly available. The Government is aiming to ensure that over 4 million homes within the next two years utilize LPG, being a cleaner fuel and aims on furthering this plan via investing and facilitating local gas cylinder manufacturing. It is in line with the Federal Government drive to boost the national usage of natural gas that Rungas Prime Industries Limited has planned to establish Type 3 Composite LPG Cylinder manufacturing Plant.

0.14.1 BENEFITS OF THE PROJECT

Rungas is a dynamic and integrated gas infrastructure company whose mission is to provide increased accessibility through its product offerings of composite LPG cylinders and other advanced LPG infrastructures that are enhanced with state-of-the-art technology to promote and ensure the widespread saturation and use of LPG (a cleaner fuel) in all homes and commercial establishments across the continent of Africa starting with Nigeria.

0.14.1.1 SOCIO- ECONOMIC BENEFITS

The project will serve as an important employment creation and will provide employment opportunity throughout the life span of the project. After construction, period the industrial and infrastructure development will provide enormous employment opportunities. The proposed type 3 composite LPG cylinder manufacturing plant will provide the following socio-economic benefits:

- enhance the accessibility the products;
- employment opportunities for the indigene;
- increase in social activities as personnel will be moving towards the area;
- more business opportunities will spring up within the host community; thereby increasing the employment opportunities and income of the indigene; and
- overall improvement in the quality of life for the lesser development areas in the neighborhood.

0.14.1.2 ENVIRONMENTAL BENEFITS

- Reduction in air pollution, due to the use of natural gas in running the generators; and
- Reduction in the emission of greenhouse gases.

0.14.1.3 NEED FOR THE PROJECT

The Federal Government of Nigeria (FGN) is targeting astronomical increase in the supply of LPG to homes in Nigeria as a medium to drastically reduce gas flaring. To stem the tide in ensuring that over 4 million homes within the next two years utilize LPG, being a cleaner fuel and aims on furthering this plan via investing and facilitating local gas cylinder manufacturing. In furtherance to the Federal Government drive to boost the national usage of natural gas that Rungas Prime Industries Limited has planned to establish Type 3 Composite LPG Cylinder manufacturing Plant. In addition to the foregoing, the proposed composite type 3 LPG cylinder has a light weight when compared with existing steel cylinders which is prone to corrosion and explosion.

0.14.1.4 THE VALUE OF THE PROJECT

The value of the project is about ₦2.96 Billion. Rungas Prime will provide an equity contribution of ₦2 Billion for the development of the Project and a debt facility of ₦857.52 Million for equipment and inventory purchase; and to augment working capital for the project. Term loan of ₦394.49 Million and Overdraft of ₦463.03 Million. The debt investment would be repaid within five years of commencing operations.

0.14.1.5 ENVISAGED SUSTAINABILITY

Rungas Prime Industries Limited has been in the business of distribution of composite LPG cylinder for decades and has acquired technical expertise in the proposed manufacturing plant. The Liquidified petroleum gas needed to run the manufacturing plant with be gotten from Shell gas plant at Gbaran within the State. Since the raw materials are within it will greatly improve the sustainability of the project and improve the economy of Nigeria. The proposed Type 3 Composite LPG manufacturing plant is expected to be sustained through proper inspection and routine maintenance of its facilities. The funding of this project is through financial institution. The proposed Type 3 Composite LPG Cylinder manufacturing plant is envisaged to be sustainable economically, socially environmentally, technically and through proper inspection and routine maintenance of its facilities.

0.14.1.6 PROJECT ALTERNATIVES

The assessment of impacts of the proposed project considered these main options; No project option, Project Relocation & the Project execution as proposed. During the Environmental Implication Study; the above project alternatives were reviewed in line with the project objectives in mind. The conclusion is that the location of the project is within the NCDMB proposed industrial hub within the acquired 11Ha of land by the Board and the communities are happy about the project, hence project execution as planned option is applicable.

“NO PROJECT OPTION”

It is essential that the “no project option” be considered as a first step in mitigation. The “no project” option implies that the proposed project will not be carried out and the area allowed to remain in its present conditions. During the study the locations of the proposed Type 3 Composite LPG Cylinder manufacturing Plant needs this project because it is within the already acquired parcel of land by the Nigerian Content Development Management Board (NCDMB) earmarked for establishment of manufacturing facilities to boost the economy of the State and the nation in general. The Federal Government through NCDMB seeks to develop local content and this project is in line with the policy.

PROJECT EXECUTION AS PLANNED

This project option was considered. During the study, it was clear that there will be employment of the indigene if the project is carried out as proposed. For instance, there will be setting up of other small scale business enterprises. Emigration will be checked, expansion of other infrastructure development will be enhanced if the project is developed as planned and as such this option was considered favourable. Liquefied petroleum gas (LPG) cylinder is a kind of pressure vessel that requires high tensile and compressive strength to store pressurized gases. This technology aims at reduction of weight of liquid petroleum gas cylinder. The commonly used material for the manufacturing of LPG cylinder is steel. But the steel is heavier and has got some safety problems. In addition to this the steel progressively corrodes.

In line with the site verification conducted by the Representatives of Federal Ministry of Environment it was agreed that the existing project location is okay since the NCDMB has acquired and approved it as an Industrial hub to boost local content plan of the Federal Government.

PROJECT RELOCATION

The option of project relocation to another location was also considered and it will not the best option as the area has been approved as an Industrial hub. This will also lead to a continued exposure of the indigene to unemployment. There will not be economic and infrastructural development. The location of the proposed project is free from any infringement from the inhabitants and does not pose any significant threat to the indigene. The host community commented that they expected the project to have started earlier than now and as such they will cooperate to make sure the project is established in their community.

0.15PROJECT PROCESS DESCRIPTION

0.15.1 PROJECT DESCRIPTION

The proposed project is a Type 3 Composite LPG Cylinder manufacturing plant with a production capacity of 400,000 units per annum. The facility will produce 80,000 units of 12kg cylinders and 320,000units of 6kg cylinders each. The technology is relatively new in the country and as such will not be obsolete soon. An LPG Composite Cylinder is superior to steel cylinder based on the following features: safety, leak detection valve, impact proof, lightweight, composite liner and does not explode in fire. The composite LPG cylinder is more durable with fifteen years requalification period as against ten years for steel gas cylinders.

0.15.2 TYPES OF PRESSURE VESSELS

Pressure vessels or cylinders are basically classified into five different types depending on the materials and processes used during manufacture.

i. Type I vessels are predominantly either steel or aluminium and are manufactured by deep drawing and cold backward extrusion, respectively. Monolithic cylinders are used in the containment of gases for industrial or laboratory applications. Heavy steel vessels are often used in applications where transport and maneuverability are not among the design criteria.

ii. Type II cylinders or vessels are types of gas cylinders manufactured with a hoop wound composite wrap. In the type II vessels, the liners are load bearing, but a unidirectional composite wrap is laid around the circumference of the vessel. As the hoop stresses in a cylindrical pressure vessel are twice the magnitude of stresses in the axial direction, the hoop wrap is used to increase the hoop strength of the vessel. Therefore, higher charging pressures can be achieved in a type II vessel when compared to an equivalent type I vessel. The type II liners are manufactured using either aluminium or steel.
iii. Type III composite cylinders are fully wrapped composite vessels, which have a metallic liner. The liner is manufactured by cold drawing of aluminium plates. The open ends of the resulting cylinders are spun to create a closed structure. The liner is then wrapped by filament winding reinforcing tows, which are impregnated with a matrix material, around the geometry of the liner. The reinforcement material used in fully wrapped vessels is usually carbon fibre tows. Carbon fibres are used due to their high strength and low density. The matrix material is often an epoxy due to its low density, excellent adhesion properties, adequate glass transition temperature and excellent corrosion resistance.
iv. The Type IV cylinders are full wrap composite vessels with a polymeric liner. The vessel liner is manufactured using a high-density polyethylene, which is produced by reactive rotational moulding. A thermoplastic polymer is placed into a mould, which is then rotated at high speed.
v. Type V vessels are a class of cylinders that have no distinct mandrel. The vessels can either be manufactured using washable mandrels or by winding over inflatable bladders. A second incarnation of the type V is the use of a composite mandrel that can then be filament wound. The advantages of a composite mandrel or mandrel-less design are the weight savings that can be achieved.

0.15.3 RAW MATERIALS AND SOURCES

The project proponent intends to promote the Nigerian economy by facilitating training and capacity building of local indigenes of Nigeria on cylinder manufacturing. In addition, the project is being set up to ensure that all raw materials will eventually be produced within Nigeria. The goal is to have an initial mix of 80% local content and 20% international content, to gain the required cylinder manufacturing skillset. Rungas prime will continually boost its level of local content in its project. The raw materials are resins, packaging materials, pallets, stretch films, gas (all to be sourced from Nigeria while valves (India) and Liners (Portugal).

0.15.4 OVERVIEW OF COMPOSITE MATERIALS IN MANUFACTURE OF LPG CYLINDERS

Composite materials are not new and have been used for many years in the automotive, marine, and aerospace industries. More recently, composite materials have use in the manufacture a variety of cylinders and containers for transportation and storage of regulated materials. Composites are highly engineered materials designed for specific applications. They are made from two or more different materials to form one single structure with an identifiable interface. The composite cylinders currently being manufactured are a polymer wrapped in fiberglass. An outer casing protects the cylinder. Construction materials include poly-acrylonitrile butadiene styrene (ABS), high-density polyethylene (HDPE), and polyethylene terephthalate (PET). The addition of carbon/epoxy to the fiberglass structure is used to provide additional stiffness. The specific materials selected for the manufacturing are designed to obtain characteristics required such as greater fracture toughness and impact resistance. Composites are stronger and stiffer than metals on a density basis, composite LPG Cylinders are corrosion free, ergonomically friendly, and easy handling, composites can be made so they are translucent, which allows the user to view the level of product inside, or they can be blended with colours, they have reduced maintenance cost, and reduced risk of static build-up and are explosion proofed.

0.15.5 SAFETY & LAYER OF PROTECTION(LOPA) FOR TYPE 3 COMPOSITE LPG CYLINDERS

The proposed type 3 composite LPG cylinder manufacturing technology has considered some level of safety and layers of protection. There are basically four levels of protection, shock absorbers located on the top and the bottom of the cylinders, help dissipate the energy from physical shocks. Secondly, Steel Liner which is coat-protected high strength steel metallic liner providing optimal safety. Thirdly, composite Layer which is between the liner and the cover rests a composite fiber, increasing lightness and resistance to shock through its malleability. Lastly, a polymeric Jacket which makes the body resistant to ultraviolet (UV) radiation and features shrouds that are both ergonomic and stackable.

0.15.6 TYPE 3 COMPOSITE LIQUEFIED PETROLEUM GAS (LPG) CYLINDER TECHNOLOGY

The technology of LPG cylinders has gone green which is a sharp turn away from the era of steel cylinders with heavy weight and ability to corrode easily. The new technology of Type 3 composite LPG cylinders is eco-friendly and LPG gases are contained in low pressure cylinders. Traditionally these were of a steel construction, but in today’s market composites and plastics are increasingly being used. To ensure that these low-pressure Type 3 cylinders are fully recyclable, there is the avoidance of the use of thermosetting resins. Instead, by opting for polypropylene to bind the fibres. It can be melted and reused just like the other plastics.

0.15.7 THE NATURE OF LIQUEFIED PETROLEUM GAS(LPG)

The Liquefied Petroleum Gas (LPG) is a colourless liquid which readily evaporates into a gas, comprising mainly propane (C3H8), propylene(C3H6), butane(C4H10) and butylene (C4H8) with vapor pressure not exceeding 16.87kg/cm2 (gauge) at 65oC. Domestic cooking gas has a remarkably high energy content (calorific value=46.1 MJ/KG). It is used as a fuel in heating appliances and vehicles. It is now increasingly used as an aerosol propellant and a refrigerant, replacing chlorofluorocarbons to reduce damage to the ozone layer. LPG is stored and handled as a liquid when under pressure inside an LPG gas container. LPG is a low carbon emitting hydrocarbon fuel, emitting 19% less CO_2 per kWh than oil and 30% less than coal. The gas can be liquefied at moderate pressure and can be stored in cylinders as a liquid under pressure and is drawn out and used as gas. This means that it can be transported and stored as liquid and burnt as gas. The expansion ratio of gas from liquid is 270:1 at atmospheric pressure. It is this expansion factor which makes LPG more economical to transport and store large quantities of gaseous fuel in a small container in liquid state.

0.15.8 PROCESS DESCRIPTION

There are three major cylinder characteristics that impact design and component selection, viz, durability, cost and weight. These features are incorporated during the design, manufacture of the composite LPG cylinders. In the manufacturing process of type 3 composite LPG cylinders the basic components and processes which are HDPE Liner (Blow molding); LPG pressure valve, fibre reinforcement (filament winding) and the housing (Injection molding process).

0.15.8.1 MANUFACTURING PROCESS

There are a select number of manufacturing processes used to produce gas cylinders. The specific manufacturing process employed in the manufacture of a cylinder is dependent on the type of material used to manufacture the cylinder. Pressure vessels are classified into Types I-V. The classifications given to specific cylinders are dependent on the materials used in the manufacturing process. Currently, cylinder types I-IV are commercially produced and operated by end users. These vessels are employed in different market sectors according to the requirements of the given application. The basic manufacturing processes of type 3 composite cylinders is outlined below.

LINER MANUFACTURE

Type III cylinder liners are manufactured by deep drawing cylindrical shells from circular plates of HDPE. The plates are placed over a forming die that is of larger diameter than the desired vessel. A cylindrical ram then forces the HDPE into the die forming a canister that is closed at one end. The process is repeated using smaller die sizes until the correct diameter is achieved. The open end of the cylinder is then closed into a dome using metal spinning techniques. A tool is used to form the contour of the neck while the liner spins at high speed.

FILAMENT WINDING EQUIPMENT

Traditional filament winding equipment consists of three main parts, the creel, the impregnator, and the wind head. A schematic layup of the filament winding equipment is shown below. The supply of reinforcement is provided from multiple packages. The packages are held on a tension-controlled creel. The tows pass from the creel to the resin impregnator then on to the wind head.

WINDING CONFIGURATIONS

Composite structures of varying laminate configurations can be produced easily by changing the parameters of the filament winding process. The orientation of the yarns is dependent on two machine variables: the rotational speed of the mandrel and the traverse speed of the reinforcement guide eye. There are two main winding configurations available to the operator. In hoop winding the reinforcement is wrapped around the circumference of the mandrel. The wind eye travels along the length of the mandrel slowly while the mandrel rotates at a high speed. Helical winding is used to wind reinforcement at lower angles. For more complex paths, such a geodesic, multi-axis Computer Numerical control (CNC) machinery is required to place the tow on the correct path by synchronizing mandrel rotations and guide manipulations.

PRE-IMPREGNATED TOW WINDING

Pre-impregnated tows, or tow-preg, can also be used in filament winding. The tows contain a partially cured resin system in addition to the fibre reinforcement. In tow-preg winding there is no longer a need for the resin impregnation stage. This has several benefits. Firstly, the tow preg is a much cleaner method of manufacture as liquid resin tends to drip and coat machinery. Secondly, any resin wastage due to exceeding pot life is eliminated. High winding tensions are required during tow preg winding. The high tow tensions ensure that the composite is well consolidated and that inter-tow voids are eliminated. In the wet process, the liquid resin is of a low enough viscosity to fill any macro porosity ensuring that the load can be transferred between lamina and between tows effectively. Resin movement during processing of pre-impregnated composite is limited in comparison.

0.16 DESCRIPTION OF PROJECT EXISTING ENVIRONMENT

0.16.1 GEOGRAPHICAL LOCATION OF STUDY AREA

The project is located within Polaku community in Yenagoa Local Government Area of Bayelsa State within the Niger Delta Region. Just like Bayelsa State, the proposed project area is a lowland characterized by tidal flats and coastal beaches, beach ridge barriers and flood plains. The proposed project site (2Ha of land) is located within the existing NCDMB 11Ha of land with GPS coordinates as stated below.

Boundary	DD Latitude:	DD Longitude:	UTM E: (m.)	UTM N: (m.)
Rungas gate 1	5.031936	6.289816	199544.567	556697.175
Rungas gate 2	5.032019	6.28995	199559.476	556706.277
Boundary B	5.030513	6.291359	199715.149	556539.074
Boundary C	5.028726	6.289157	199469.956	556342.282
Boundary D	5.029415	6.286173	199139.113	556419.862
Boundary E	5.030311	6.286357	199159.944	556519.021
Boundary F	5.030896	6.288158	199360.077	556582.849
Boundary G	5.030908	6.288388	199385.567	556584.125
Boundary H	5.030956	6.288626	199412.025	556589.281
Boundary I	5.03105	6.288814	199432.919	556599.625
Boundary J	5.031176	6.289136	199468.71	556613.436
Boundary K	5.03147	6.289117	199466.703	556645.965

0.16.2 METEOROLOGY AND CLIMATE

The meteorology of Nigeria is briefly classified under South and North zone. Distinctly two season's annually wet season and dry season in project influence within the State and Nigeria in general. The project falls under south-West zone hence long dry season persist a long time from October to April while rest of months of a year included under wet seasons. Generally, the dry season starts with Harmattan-a dry chilly spell that lasts until February and a dusty atmosphere is brought about by the northeast winds blowing from the Arabian Peninsula across the hot Sahara Desert. Generally, temperatures are high throughout the year because Nigeria lies within the tropics and the mean monthly figure could go above 28.4 0C, while daily maximum temperatures can go beyond 32.8 0C.

RAINFALL

Rainfall in Bayelsa State varies in quantity from one area to another. Just like Bayelsa State, the project area experiences equatorial type of climate. Rain occurs generally every month of the year with heavy downpour. Rainfall varies from place to place and from season to season. In the wet season, the full effect of the tropical maritime air mass is the main reason that brings rainfall, while in the dry season the rainfall is less. The total annual rainfall decreases from the south to the north. Rain falls throughout the year in Yenagoa and the most rain falls around April to September 4, with an average total accumulation of 15.0 inches.

TEMPERATURE, CLOUD COVER AND PRECIPITATION

The mean monthly temperature is in the range of 25°C to 31°C. Mean maximum monthly temperatures range from 26°C to 31°C. The mean annual temperature is uniform for the entire Bayelsa State. The hottest months are December to April. The difference between the wet season and dry season on temperatures is about 2°C at the most. The average ambient temperature measured during the study was 31.2°C.

RELATIVE HUMIDITY

Relative humidity is high in the state throughout the year and decreases slightly in the dry season. The ambient temperature and relative humidity of the project location were measured using the Smart Sensor (Model: AR830) which can measure Relative Humidity, Temperature and Particulate Matter. The average relative humidity measured during the study was 56%.

WIND SPEED AND DIRECTION

The average annual speed in the project area as it is related to Yenagoa ranges from 1.2m/s in April and 2.3m/s in November. The measured average wind speed within the project site was 1.3m/s. The wind rose for Yenagoa shows how many hours per year the wind blows from the indicated direction (SW: Wind is blowing from South-West and (SW) to North-East (NE).

0.16.3 PHYSIOGRAPHY AND GEOLOGY

The proposed project is located approximately within Yenagoa Local Government area of Bayelsa State. The vegetation of the state is transitional between the Guinea and Sudan Savanna. There are two distinct seasons, the rainy season extends from April to October and the dry season is between November and April. The mean annual temperature ranges between 23.00C to 33.00C. The annual rainfall within 15inches. The project is within Yenagoa in Bayelsa State and it is located within the lower Delta plain believed to have been formed during the Holocene of the quaternary period by the accumulation of sedimentary deposits. The major geological characteristic of the state is sedimentary alluvium. The entire state is formed of abandoned beach ridges and due to many tributaries of the River Niger, Nun River & Taylor creek in this plain, considerable geological changes still abound.

0.16.4 BASELINE DATA ACQUISITION METHODOLOGY AND STUDY APPROACH

The purpose of the baseline data acquisition is to establish the status of the various environmental components before the execution of the project. To achieve this, the environmental parameters were acquired from data gathering. The components of the environment covered are biophysical, social, and health.

0.16.5 QUALITY ASSURANCE/QUALITY CONTROL

The quality control & quality assurance (QA/QC) of all samples and the whole process is a vital aspect of this project and the conduct of the Environmental Implication study. This starts from field works, collection of samples, analysis and documentations. Standard methods and procedures have been strictly adhered to during this study. QA/QC procedures were implemented during sample collection, labelling, analyses and data verification. Chain of custody procedures including sample handling, transportation, logging and cross-checking in the laboratory have also been implemented. All analyses were carried out in DPR/FMENV/NESREA accredited laboratories (International Energy Services Limited). The methods of analyses used in this study were in compliance with nationally and other internationally accepted analytical procedures, to ensure the reliability and integrity of the data obtained.

0.16.6 SAMPLING STRATEGY

The sampling strategy is an essential component of quality assurance and quality control. The sampling and data collection for the environmental components and parameters were in accordance with recommended procedures and practices for environmental data collection in Nigeria (FMENV 1992 and DPR, 2002 Part vii D – sampling and handling of samples). This is done to ensure that the nature, characteristics of the samples is not altered in any way. Samples were collected and stored in coolers to maintain their characteristics and compositions.

0.16.7 AIR QUALITY AND NOISE STUDIES

The rate of air pollution is becoming worrisome and therefore needs an urgent redress. It is becoming a major factor in the quality of life of urban and rural dwellers, and it poses risk to both human health and the environment. Therefore, it is necessary to study the background quality of the air prior to any project and to predict the impact(s) such a project would have on the air quality. Thus, the following air quality parameters were sampled during the field work viz: Suspended Particulate Matter (SPM), Sulphur Oxides (SO_X), Nitrogen Oxides (NOx), Carbon Monoxide (CO), Hydrogen Sulphide (H_2S), and Hydrocarbon gases using highly sensitive digital in-situ Gas Monitors. The background noise levels were measured using a portable digital sound level meter.

0.16.8 SOIL CHARACTERISTICS/ LAND USE & OWNERSHIP

Soils in Bayelsa State are varied per the geological history and soil formation processes in the different localities. The study location is characterized by a typical freshwater ecology of the upper reaches of the River Nun and Taylor creek within the Yenagoa, Bayelsa State. The study area lies within the outcropping Benin Formation made up of continental deposits of Miocene to recent sediments. The area is associated with freshwater swamps, backswamps and meander belts of flat to sub-horizontal elevation. The well drained clay soils of the hill crest and slopes are very important because they provide the best soils for the cultivation of food crops in the state. The lighter loams are more suitable for cultivation the local food crops, such as yam, cassava, potato, plantain, and maize. Soil degradation and soil erosion are generally not serious in the project area. The soil in the project location is predominantly loamy soil with clay, rich in iron content which makes it good for agricultural purpose. The physico–chemical characteristics of soils samples in both top and bottom obtained during the study of the proposed project areas are presented below. The soils of the proposed project area were generally sandy-clay-loam to sand. The textural distribution varies from sand to sandy, clay, silt from surface to sub-soil indicating a fertile soil for agriculture. The colour of the soil samples varies from yellow, light brown, dark brown and black. There is sedimentary rock composition, which helps to support savannah vegetation. Eighteen (18) soil samples at nine locations at depth 0-15cm and 15-30cm were collected within the project area with the aid of a Dutch Hand Auger, hand gloves, a spool and hammer. The pH values of the surface subsurface (0– 30cm) soils of the study area showed that the soils are slightly acidic with values that range from 5.0- 6.5 for the sub-surface.

The electrical conductivities of the range in subsurface soils were 6.0 – 105µS/cm.

The TOC level for the subsurface soil samples ranged from <0.1% to 3.1%.

Nutrients: Nitrate concentrations in soil samples ranged in the subsurface layer nitrate ranged from <0.01– 0.09mg/kg. Total nitrogen in the subsurface ranged from <0.1 – 1.2mg/kg. Concentration of ammonium in the soil samples ranged from <0.01-0.53mg/kg. Sulphate concentrations in soil samples in the subsurface layer ranged from <1.0-4.0mg/kg; nitrite ranged from <0.001– 0.004 mg/kg.

Heavy Metals

The concentrations range of heavy metals for surface and subsurface soil samples (Cr, Fe, Hg, Mn, Ni, Pb, Cu, Zn, and V) in the study area are presented below:

Chromium*:* The concentration of total Chromium is <<0.001-0.601mg/kg for subsurface soil.

Total Iron*:* The surface soil of the iron level ranged from 3288-33455 mg/kg. The soil samples are rich in iron which accounts for the good agricultural yield within the community.

Mercury: The concentration of Mercury was below equipment detectable limit of <0.001mg/kg subsurface soil.

Manganese*:* The manganese level of the subsurface soil has a value range <0.001-0.382mg/kg.

Nickel: The recorded values for nickel in the soil samples ranged from <0.001-3.524mg/kg

Lead: The concentrations of lead in the soil samples ranged from <0.001-73.91mg/kg.

Copper: The surface soil of the subsurface soil has values that ranged between 0.001-3.572mg/kg.

Zinc: The concentration of zinc in the soil samples ranged from <0.001-58.12mg/kg.

Vanadium: The concentration of the metal was below equipment detectable limit of 0.001mg/kg subsurface soil.

MICROBIOLOGICAL STATUS OF SOILS

Results of microbial analyses of the soil samples are presented below. Results of Total Heterotrophic Bacteria Count (THB) for soil samples collected from 0 – 30cm depth have values that ranged from 1.2 – 2.0 x 10^2cfu/g. Results of Total Heterotrophic Fungi Count (THF) for soil samples collected from 0 – 15 & 15- 30cm depth have values that ranged from 5.20X10^5– 1.78X10^6cfu/g. The values of HUB for the soil samples ranged from 5.10X10^5- 1.15X10^6cfu/g and the values of HUF the soil samples collected ranged from 1.70X10^5-5.40X10^5. The values of THB of the soil samples ranged from 1.38X10^6-2.78X$10^{6.}$

0.16.9 HYDROLOGY

Bayelsa State has a riverine and estuarine setting with many communities almost surrounded by water, making them inaccessible by road. Groundwater occurrence in Bayelsa State can be grouped into three. These are: weathered/fractured basement complex, newer basalts & river alluvium. In the basement complex that characterizes a significant portion of the geological structure of Bayelsa State, it is only possible to find water when the rock is decomposed/weathered, in such a way as to allow the infiltration of a certain amount of water within the rock joints. This determines the creation of an accumulation of water which is dependent on the degree of rock covering the impermeable rock. Thus, the main source of groundwater in crystalline rocks is the weathered zone or the fractured basement.

GROUND WATER SAMPLES LABORATORY RESULTS

Three ground water samples were taken for analysis. The ground water sampling was conducted at three points from boreholes within Polaku community in the presence of the FMENV Representatives monitoring the data gathering same day with soil sampling.

The insitu parameter values for ground water a like pH, Electrical conductivity, temperature, TDS & dissolved oxygen were measured with the results as shown below. From the insitu measurement, the pH of the ground water samples were slightly acidic within the required range of (5.2-5.7), conductivity values ranged from 122.0-172 µS/cm dissolved oxygen values ranged from (4.2-7.8mg/L) and Total Dissolved Solids values ranged from (75-86mg/L).

Turbidity values of the ground water samples were in the range of 0.9-1.2NTU

The mean temperature of the borehole samples 23.36^{o}C.

CHEMICAL PARAMETERS

The chemical parameters are Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Hardness, asbestos or any dust system containing fibers of the correct size, namely 0.1 μ m diameter and 2-20μm long, the heavy Metals, Aluminum (Al), Iron (Fe), Manganese (Mn), Lead (Pb)), the eight trace elements, (As, Cd, Cu, Cr, Pb, Hg, Ni, and Zn). Trace elements are elements that are generally present only in small quantities in natural systems.

The other parameters are the anions (Fluorides, Chlorides, Sulphate, Nitrogen, Phosphorus), Acidity, Alkalinity and pH, Toxic and radioactive substances. The values of these parameters are as stated on the above table. The values of sulphate was <1mg/L, Nitrate values ranged 0.02-0.07mg/L, ammonium values ranged from 0.05-0.09mg/L, chlorides values ranged from 14.2-24.3mg/L.

Metals & Heavy metals

Iron content in the borehole water samples ranged from 0.109-0.573mg/L, Potassium ranged from 0.230-0.626mg/L, Sodium ranged from 3.227-5.321mg/L, Magnesium content values ranged from 0.162-0.185mg/L, Calcium contents values ranged from 0.358-0.381mg/L. The lead (Pb) contents ranged from <0.001-0.004mg/L, Zinc value was <0.001mg/L, Cadmium was <0.001mg/L, Nickel value was <0.001mg/L, Mercury was <0.001mg/L, Copper value was <0.001mg/L, Chromium was <0.001mg/L.

MICROBIOLOGICAL PARAMETERS

The microorganisms of interest are a group of bacteria called Coliforms and for human contamination we rely on Escherichia Coli (E. coli). The value of E. Coli ranged from 10-25(MPN/100 ml). The values of THB ranged from 1.41X10^{2}-2.23X10^{2}Cfu/ml, HUB values ranged from 1.28x10^{2} - 9.20x10^{2}(Cfu/ml), THF results ranged from 1.11X10^{2} -1.31X10^{2} (Cfu/ml), and HUF values ranged from 1.80X10^{2} -2.70X10^{2}(Cfu/ml).

SURFACE WATER LABORATORY RESULTS

Four surface water samples were collected along the Taylor Creek(The control point at the upstream along Taylor creek, upstream at the confluence(Taylor Creek/Nun River), mid-stream at the proposed project site and down-stream after the project site.

PHYSICAL PARAMETERS

The physical parameters are turbidity, temperature, colour, taste and odour.

Turbidity: The mean value of turbidity of the surface water samples was 6.2NTU.

Temperature: The mean value for surface water temperature was 23.0^{o}C.

Colour, Taste, and Odour: These are physical characteristics that are important for the quality of the water. Although they do not cause direct physical harm, most people would object strongly to water that offends their sense of sight, taste, and smell. Too much colour impairs light penetration in a body of water and could affect the food chain. The colour of the surface water was 1 Pt./Co.

CHEMICAL PARAMETERS

The chemical parameters are Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Hardness, asbestos or any dust system containing fibers of the correct size, namely 0.1 μ m diameter and 2-20μm long, the heavy Metals, Aluminum (Al), Iron (Fe), Manganese (Mn), Lead (Pb)), the eight trace elements, (As, Cd, Cu, Cr, Pb, Hg, Ni, and Zn). Trace elements are elements that are generally present only in small quantities in natural systems.

The other parameters are the anions (Fluorides, Chlorides, Sulphate, Nitrogen, Phosphorus), Acidity, Alkalinity and pH, Toxic and radioactive substances. The values of these parameters are as stated on the above table. The value of sulphate was <1mg/L, Nitrate values ranged 0.02-0.03mg/L, ammonium values ranged from 0.03-0.04mg/L, chloride value was 8.9mg/L.

Metals & Heavy metals

Iron content in the borehole water samples ranged from 0.985-1.461mg/L, Potassium ranged from 0.996-1.211mg/L, Sodium ranged from 0.056-0.063mg/L, Magnesium content values ranged from 1.121-1.219mg/L, Calcium contents values ranged from 0.347-0.361mg/L. The lead (Pb) contents ranged from 0.335-0.982mg/L, Zinc value was <0.001mg/L, Cadmium was <0.001mg/L, Nickel value ranged from <0.001-0.004mg/L, Mercury was <0.001mg/L, Copper values ranged from 0.114-0.282mg/L, Chromium was 0.011-0.078mg/L.

MICROBIOLOGICAL PARAMETERS

The microorganisms of interest are a group of bacteria called Coliforms and for human contamination we rely on Escherichia Coli (E. coli). The value of E. Coli ranged from 18-35(MPN/100 ml). The values of THB ranged from 2.12 x 10^2-2.93X10^2Cfu/ml, HUB values ranged from 1.32x10^2 – 1.68x10^2(Cfu/ml), THF results ranged from 1.42X10^2 -1.83X10^2 (Cfu/ml), and HUF values ranged from 0.0 -3.70 x 10^2(Cfu/ml).

SEDIMENT

Environmental degradation & pollution is a major concern globally and it requires concerted effort. This is due to anthropogenic activities in urbanization, industrialization and population growth. Pollution of environmental components (soil, water and air) is on the increase in many developing nations. The air pollutants are mainly in the form of odour, noxious gases and air particulates. When aerosols are formed, air particulates have the tendency to be deposited in the soil and surface water systems.

Bottom sediments are highly valuable as they provide useful information about the quality of aquatic ecosystems. As such, the ability of living organisms to survive in aquatic ecosystems depends on the water and sediment quality. Due to their nature, both organic and inorganic materials found embedded in the aquatic ecosystem as sediments. They are distributed as fine materials as clay, silt, and sand with diameter <2 mm); coarse materials (such as gravel, bedrock), (inorganics) and decomposable materials (such as animal matter, aquatic plants, etc), (organics). In line with FMENV directive four sediment samples were collected from the Taylor Creek using the grab sampler.

PHYSICOCHEMICAL PROPERTIES OF SEDIMENTS

The physicochemical characteristics of sediment samples collected from Taylor Creek at four (4) locations. The study is a one-season data gathering which was during the wet season. The laboratory reports are shown below. The mean pH value was 5.5, the mean values of Nitrate was 0.58mg/kg, while the mean value for chloride content was 4.5mg/kg.

CHARACTERISTICS OF SEDIMENT MICROBIOLOGY

From the laboratory analysis results of the sediment samples, the total heterotrophic bacterial count (cfu/g) of the sediment ranged from 2.10X10^6 – 2.27X10^6. The values of HUB ranged from 2.10X10^5-6.60X10^5 while THF values ranged from1.86X10^5- 2.73X10^5 and HUF values ranged from 1.80X10^5 - 2.80X10^5.

0.16.10 LAND USE & LAND COVER

The land cover classification was done using satellite imagery from Sentinel 2A L1C Tile in JPEG2000 format with geo-location of the proposed project area. Satellite Sentinel-2 imagery data set was available from United States Geological Survey (USGS), the Sentinel-2 data were acquired, processed, and generated by the European Space Agency (ESA) and repackaged by USGS.

The imagery used for this classification was acquired on the 10th of August 2020. The classified image shows different prominent land use and land cover types within the proposed project area. These are buildings (built-up areas), vegetation (secondary vegetation), and barren (bare soil). After classification the land use area occupied by each land use type was calculated and this indicated that the proposed project area is largely an undeveloped land with built-up area representing about 0.51%, vegetation cover which is mainly secondary growth about 61.67% and barren (bare soil) cover represent about 37.88% of the total land mass.

0.16.11 SITE'S NATURAL CHARACTERISTICS

The proposed site is on a sand-filled area within Polaku originally earmarked by the Nigerian Content Development & Monitoring Board (NCDMB) for industrial activities which is characterised by Rain Forest Zone with lots of vegetations, trees and food crops like, plantains, pineapple, cassava and other leguminous plants. The area is also a natural open space covered by natural indigenous vegetation which is suitable for agricultural purpose, but this has been designated as industrial hub. These areas play an important role in providing natural habitats for biodiversity within the landscape.

0.16.12 TOPOGRAPHY, ECOLOGY AND GEOLOGY OF AREA

The topography of the proposed project location is flat, slopping gently towards the Taylor creek. The project area is on a low land. Various forms of morphological units and depositional environments have been recognised in the study area, ranging from coastal flats, sand bars, ancient/modern sea, river and lagoon beaches, flood plains, seasonal flooded depressions, swamps, ancient creeks, and river channels. The geographical landscape of the area and the entire state comprises extensive fertile soil loamy soil suitable for agriculture, because of the presence of grasses it is suitable for cattle rearing and farming. The adjoining area is predominantly savannah ecosystem. There are also vast forest reserves, rivers, lagoons, rocks, mineral deposits. Geologically, extensive deposits of sandstone, mineral deposits occur within the Local Government and the State. A topographic map is a two-dimensional representation of the Earth's three-dimensional landscape. It is a two-dimensional representation of a portion of the three-dimensional surface of the earth. Topography is the shape of the land surface, and topographic maps exist to represent the land surface. Using the ASTER DEM (Advanced Spaceborne Thermal Emission and Reflection Radiometer), the Digital Elevation Model of the proposed project area was extracted and used to compute the contour, hillshade, slope, aspect and aspect-slope map to determine its topographic features.

0.16.13 VEGETATION & WILDLIFE

The vegetation of Bayelsa State like other Niger Delta, comprises four ecological logical zones. These include coastal barrier island forests, mangrove forests, freshwater swamp e.g. forests and lowland rain forests. These different or vegetation types are associated with the various soil units in the area, and they constitute part of the complex Niger Delta ecosystems.

The vegetation study focused more on the forest locations of the proposed project environment where, though human activities such as hunting and timbering activities were not all that heavy, but there was evidence of some relatively lightly disturbed habitats expected to still retain wildlife and are sites of gathering of bush mangoes (ogbono) and spices with modified fish pond activities. There was evidence of economically important non-timber plants of economic value and high floristic diversity. The forest around the facility though degraded by past logging and hunting was observed to be a good example of a typical secondary raphia seasonal swamp forest undergoing regeneration and to harbor interesting diversity of vegetation, such as raphia species, symphoria globulifera, mitragyna species (abura), Irvingia gabonensis (ogbono). We even observed ogbono camps for seasonal gathering and processing of these important economic crops and other food crops.

0.16.14 AQUATIC STUDIES/HYDROBIOLOGY

The natural exchange between surface water and groundwater supplies create a link that calls for a holistic approach to aquatic ecosystem assessment and management. Aquatic systems such as lakes, ponds, and wetlands also provide important hydrological support for anthropogenic activities through their roles in water conveyance and storage. There are sources of natural water (Taylor Creek & Nun River) bordering the study area. The Taylor creek is a source of livelihood to the community as lot of fishing and other industrial activities take place along the creek such as the Shell Gas-Gbarain and the Kolo Power Station.

Benthic macrofauna samples were collected using Eckman’s grab, the samples were sieved immediately after retrieval from water and the grab contents emptied into the sieving bag and screened through a 0.5mm mesh sieve using water. The sediment and faunal materials retained by the sieve were transferred to a sealed plastic container, labelled, and preserved in 10% buffered formalin solution and transported to the laboratory. In the lab, the samples were emptied into white tray and sorted. All the animals in the sorted samples were preserved with 75% ethanol in vial containers. These were identified to the lowest possible taxonomic levels under the stereo microscope and individuals of each taxonomic group were counted and recorded.

BENTHOS RESULTS

Of the four stations established for benthic studies, the macro-fauna assemblages from the four (4) sampled points consisted of various forms of aquatic organisms. The organisms are classified into 4 major taxonomic groups such as Oligochaeta, Insecta, Crustacea and Gastropoda. The Oligochaeta had the highest number of species and population of individual organisms. The group was represented by four (4) species with total number of 50 organisms (47.2%) of the total stock of benthic organisms recorded during the study, followed by insect with 2 species and a total of 22 organisms (20.8%), the Crustacea also with 2 species contributed 20 organisms constituting 18.9% and the Gastropoda with only one specie contributed 13.2%

PHYTOPLANKTON

These are the organisms that occupy the lowest tropic level which other life depend directly or indirectly on as a primary food source. Phytoplankton samples were collected using plankton net tow on a boat moving along the river. After each tow, the samples were emptied into vial container and preserved with 5% formalin stained with eosin. These were transported to the laboratory for analyses. In the lab, the samples were allowed to stand for 24 hours. Pipette dropper was used to collect preserved sample, 1 ml concentrated sample was properly homogenized and transferred into a sedge wick Rafter counting chamber using sample pipette. The organisms were identified and enumerated under a binocular microscope (140 – 144x). The phytoplanktons are the primary producers of the food web. They form the bases of which other lives depend upon for food and nutrients, without them life will not be complete and therefore are regarded as the most important group of organisms in life.

The phytoplanktons are made up of Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae as recorded during the baseline studies in the area. The Bacillariophyceae had 17 species distributed across the various sampled stations, the total number of organisms were 274 individuals contributing about 53.7% of the total phytoplankton stock harvested during the study period were rated highest amongst the groups followed by Chlorophyceae with 32.7%. Euglena was the lowest contributing 4.1%.

ZOOPLANKTON

These are organisms made of the juvenile and larval stages of larger animals such as zoea, shrimps zoea, fish larva/embryo, vegiller of larvae of molluscs, and permanent zooplankton, such as copepods, insects, annelids, etc. The zooplankton sampling was carried out with the aim of identifying the various taxonomic groups of zooplankters. The various taxas chosen at the station were enumerated, with which an index or their abundance in relationship to the level of pollutants could be established. The method follows that subsurface water were towed through plankton net for some minutes and the organisms retained in the net were emptied into vial containers and preserved just the same way and manner as that of phytoplankton and analysed the same way. Following a thorough agitation and homogenization, 1ml sub-samples were taken using a sample pipette and transferred to a graduated 1ml counting chamber for observation under a microscope with magnification of 40 to 400x. The organisms were simultaneously identified and enumerated, and results entered on analysis sheets.

The major taxonomic groups encountered includes Cladocera with 6 species and a total of 143 individual organisms (43.7%) of the total zooplankton stock, Copepoda was second with 95 organisms (29.1%), Protozoa 57 individuals (17.4%) and Decapoda with 2 species had 32 individual organisms (9.8%). The Zooplankton which are the primary consumers depends on the abundance of phytoplankton for food, while the abundance and composition of phytoplankton is a function of available nutrient in an ecosystem, season and other environmental factors.

0.16.15 FISH AND FISHERIES

Fishing is the major traditional occupation of the people in Polaku town. This is carried out in the surrounding Taylor creek and Nun River close to the community. There were no commercial fishers, artisanal fishers or small-scale fishers dominate the fishery of the area. They operate in dug-out wooden canoes, plank wooden canoes which may or may not be motorized. Fishing gear were largely made of manually operated traps, cast net, long setlines, circling nets and seine nets, gill nets, drift nets of different mesh sizes varying from ½”, 1”, 1½”, 2”, 2½ to 3” and 3 to 4”.

The families and fish species identified from catches of artisanal fishers in the study area (Polaku Town) are presented in the ESIA report. A total of 50 fish species belonging to 20 families were identified during the study period. Out of which, 47 of them are fin fish comprising of the family Mochokidae with 7 species (Synodontis clarias, Synodontis membranaceous, Synodontis sorex, Synodontis ocellifer, Synodontis nigrita, Synodontis schall and Synodontis melanopterus), Mormyridae with 4 species (Mormyrus rume, Hyperopisus bebe, Mormyrops deliciosus and Mormyrus deboensis). Other families are Alestidae with 5 species (Brycinus nurse, Alestes baremose, Hydrocynus brevis, Hydrocynus forskalii and Alestes dentex), Clariidae 2 species (Heterobranchus bidorsalis, Heterobranchus longifilis), Bagridae 3 species (Bagrus filamentosus, Bagrus bayad, Bagrus docmac), Claroteidae 3 species (Chrysichythys nigrodigitatus, Clarotes laticeps and Chrysichthys auratus), Distichodontidae with 2 species (Distichodus rostratus and Distichodus engycephalus), Cichlidae 3 species (Oreochromis niloticus, Tilapia zilli and Hemichromis fasciatus, Malapteruridae 1 species (Malapterurus electricus), Latidae 1 species (Lates niloticus), Citharinidae 3 species (Citharinus citharus, Citharinus latus and Citharinus thomasi), Cyprinidae 2 species (Labeo coubie and Labeo senegalensis), Notopteridae 1 species (Polypterus senegalus), Arapaimidae 1 species (Heterotis niloticus), Eleoteridae 1 species (Eleotris senegalensis), Gymnarchidae 1 species (Gymnarchus niloticus), Hepsetidae 1 species (Hepsetus odoe) and Schilbeidae 3 species (Schilbe intermedius, Schilbe mystus and Schilbe isidori) while 3 of the fish species are fin fish from the family Paleomonidae with 3 species (Macrobrachium felicinum, Macrobrachium vollenhovenii and Macrobrachium macrobrachion). The dominant fin fish species were Chrysichthys nigrodigitatus, Distichodus rostratus, Bagrus bayad, Synodontis sorex and Mormyrus rume while the shellfish was dominated by Macrobrachium felicinum, Macrobrachium vollenhovenii and Macrobrachium macrobrachion. The health status of the fishes was satisfactory, and the specimens were of medium size and showed no evidence of pathological deformities.

0.16.16 SOCIO- ECONOMICS

During the Environmental studies, the socio-economic data gathered comprises historical information, cultural norms, land tenure and land use pattern, population and demographic characteristics, health, morbidity, mortality, and fertility, occupations and income distribution, health social and other infrastructure. The Local Government Area in Bayelsa State as the Local Government Area hosting the project has one of the largest crude oil and natural gas deposits in Nigeria. As a result, petroleum production is extensive in the state. However, the majority of Bayelsans live in poverty. They are mainly rural dwellers due to the terrain and lack of adequate transportation, health, education or other infrastructure. This has been a large problem in the state since its creation; successive state governments have not been able to address and repair the issue. The Polaku community does not have industries or company operating in the community as compared to other neighbouring communities, a reason why the community embraced the proposed project.

The available social amenities such as were assessed during the studies.

0.16.17 HEALTH STATUS

The field survey of the study area for the health data gathering was undertaken covering the Polaku community. There are health facilities within the project location such as the

Niger Delta University Teaching Hospital to take care of the health needs of the community. During the field activities and interactions with inhabitants of the community the following methods were deployed, oral interviews, physical observations, Focus Group Discussions (FGD) held separately with adults, women and youths and Socio-demographic data, with associated health impact.

0.17PUBLIC CONSULTATION

0.17.1 INTRODUCTION

The public participation process comprises an important step in identifying issues and expected impacts of the proposed development that may affect the natural and/or socio-economic environment. Consultation as part of the Environmental assessment process is a critical component in achieving transparent decision-making. Public consultations for the proposed composite LPG cylinder production plant were conducted as required in the Environmental Impact Assessment Decree. Door to door public consultations were conducted for the residents neighbouring the project site. Questionnaires were also distributed personally and through the Chiefs to the indigenes to enable us to get the opinion. Sixty (60) questionnaires were personally (besides those by the chiefs who suggested will reach the locals) distributed to cut across the youth, women, men/chiefs of the project area. The consultation and stakeholder’s sessions were held between 24th -28th August 2020. The stakeholder’s workshop was done limiting the number of participants while complying with NCDC Guidelines of social distancing. Everybody in attendance was presented with Nose mask.

0.17.2 OBJECTIVES OF THE CONSULTATION AND PUBLIC PARTICIPATION

The objective of the Consultation and Public Participation (CPP) is to: -

- disseminate and inform the public and other stakeholders about the proposed mixed residential, institutional, and recreational and facility support infrastructure project with special reference to its key components, location and expected impacts.
- awareness among the public on the need for the Environmental & Social Impact Assessment for the proposed project.
- gather comments, concerns and suggestions of the interested and, would be affected/ interested parties.
- ensure that the concerns of the interested and, would be affected/interested parties were known to the decision-making bodies and the proponent at an early phase of project development planning.

0.17.3 PROCESS OF ENGAGEMENT

Public, or stakeholders’ and Interested and Affected Parties’ (I&AP’s) participation formed an integral part of this ESIA process. The main purpose of which was to:

- present the intended development as known to the consultants to all stakeholders, and IAP;
- provide stakeholders and IAP with information on the intended development that may bear directly on their health, welfare, and quality of life;
- enable stakeholders to make an informed and objective decision concerning the intended development;
- provide stakeholders and IAP the opportunity to raise their concerns regarding the intended development;
- record the issues and concerns of stakeholders and IAP.

0.17.4 NOTIFICATION

The following means were used to inform stakeholders and I&AP's of the proposed development:

- the project was registered with the Federal Ministry of Environment;
- focused group discussion; and
- house to house consultation.

0.17.5 OPPORTUNITIES

The following opportunities were available to contribute/comment:

- Registration of the Environmental & Social Impact Assessment (ESIA) with Federal Ministry of Environment, preparation of Terms of Reference and communication with the consultant.
- Registering comments/concerns raised by stakeholders.

0.17.6 STAKEHOLDERS AND INTERESTED PARTIED & AFFECTED PARTIES

Questionnaires were distributed to the residents and those that may be affected by the project for their comments within Polaku Community in Yenagoa. Notably, FRSC, Divisional Police Officer- Agudama, Chief Medical Director- Niger Delta University Teaching Hospital, Nigerian Content Development & Monitoring Board (NCDMB), Chairman Yenagoa Local Government Area, Ijaw Youth Council (IYC), Polaku, Gbarain Youth Federation, were also invited. Their comments were supporting the establishment of the project. The communities need the projects as it will improve on their welfare and means of livelihood.

0.17.7 SOCIO- ECONOMIC PROFILE

The Socio-economic survey for the households was commenced 24th of August 2020. The socio-economic survey was carried out with an objective to capture the following information:

- Income and Expenditure pattern;
- Holdings of durable commodities;

- Details of available facilities like drinking water, electricity and toilets;
- Migration pattern for work and purpose of migration;
- Health and disease pattern;
- Treatment facilities and type of treatment chosen;
- Involvement of women in various activities;
- Involvement of women in decision making;
- Son preference and attitude towards girl child;

0.18 ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACTS

0.18.1 INTRODUCTION

This Chapter contains summary of impacts that are inherent with the project because of the interaction between various project components and environmental elements. The method of impact identified and evaluated is also given in this chapter. Several potential impacts associated with the proposed development have been identified through the public participation process, baseline data acquisition process and biophysical specialist assessment. The impacts cover all project phases, i.e. planning and design, preconstruction, construction, and operation.

0.18.1.1 ASSESSMENT CRITERIA

The criteria developed for the assessment of the affected environment is based on the requirements as stipulated by the regulatory Agencies, regulations and WHO regulations. It seeks a balance that promotes economic development on the one hand and the conservation of visual, aesthetic, tourism, environmental and heritage characteristics and resources of the study area on the other hand.

0.18.2 ANTICIPATED ENVIRONMENTAL & SOCIAL IMPACTS

The environmental impacts caused due to the development of the project can be categorized as primary (direct) and secondary (indirect) impacts. Primary impacts are those which are induced directly by the project whereas the secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns of social and economic activities due to the proposed action. These impacts are;

- Loss of vegetation due to cutting of trees
- Loss of Topsoil due to clearing & grubbing of new alignment.
- Temporary impacts in terms of polluted environment on flora and fauna due to the construction activities.
- Impacts on the drainage pattern due to raised embankment, introduction of new culverts.
- Impacts on traffic management system.
- Increased air pollution (including dust) during project construction.

0.18.3 PHYSICAL ENVIRONMENT

0.18.3.1 Climatological Parameter

Though no change in the macro-climatic setting (precipitation, temperature and wind) is envisaged due to the project, the microclimate is likely to be temporarily modified by vegetation. There will be an increase in daytime temperature arising from some heat that will be generated from the factory and soil due to loss of shade and vegetation, which in turn might lead to formation of heat islands especially along the inhabited sections. However, it may be pointed out that the entire stretch is blessed with natural vegetation on either side of the Industrial hub and hence the impact on meteorological parameter will be temporary in nature and with the growth of vegetation such impact will be minimized.

0.19.4 Mitigation Measures

In this report mitigation measures have been developed for the identified negative environmental impacts. However, green belt development and tree planting shall be undertaken to conserve the affected species. Such tree plantation will restore the microclimate of the region as a mitigation measure. Project activities involve alterations in the local physiography and drainage patterns. The impacts on physiography may include de-stabilization arising from slopes due to cut and fill operations. Cut-and-fills will be designed for improvement to the area geometry, and drainage structures will be added to improve drainage. Incorporating appropriate type of treatments of slopes has reduced the potential for erosion of high embankments and culvert area filling. The topography of the project area is smooth while adjoining areas have gentle slope. The side slopes gentler than this will be turfed with shrubs and grasses. Vegetations that will be removed during construction stage will be replenished by planting ornamental shrubs and grasses.

0.19ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental & Social Management Action Plan (ESMP) is required to ensure sustainable development of the project during construction and operational phases. ESMP is location and time specific. In general, Federal Ministry of Environment is responsible for enforcement of mitigation measures.

0.20.1 ENVIRONMENTAL MONITORING PROGRAM

The Environmental Monitoring Programme has been detailed as a stand-alone document. Successful implementation of the Environmental Monitoring Program is contingent on the following:

- The Project Proponent shall ensure compliance with the environmental monitoring plan.

- Submission of monthly air quality and waste water monitoring results to Federal Ministry of Environment

0.20.2 IMPLEMENTATION AND MONITORING

This section provides an assessment of the existing institutional arrangement within Federal Ministry of Environment, the state Government and, reflects on capacity building / training issues that need to be addressed to ensure timely implementation of ESMP. The institutional arrangement proposed for this project has been presented here with newly defined roles and responsibilities. The responsibility of implementing the mitigation measures lies with the project proponent and the Federal Ministry of Environment. Rungas Prime Industries Limited will be responsible for planning all Environmental & Social Management Plan (ESMP) activities. In the pre-construction phase of the project Rungas Prime Industries Limited civil contractor shall study the ESMP to identify environmental issues and arrive at a suitable strategy for implementation.

0.20.3 ENVIRONMENTAL CAPACITY BUILDING

Training of staff will be done at different levels. Some short-term training is required for the Environment Manager, other staff members of the Environment Unit and the contractor staff to raise their levels of environmental awareness. The training can be conducted by either some external agency or through the help of in-house expertise of the consultants. In the long-term training, special environmental issues will be examined and likely solutions provided to the Environment Department. The essence of these trainings is to ensure compliance with environmental management plan throughout the project life span.

0.21 DECOMMISSIONING AND REMEDIATION PLAN

In case the plant will be shut-down, the site will progress through decommissioning, remediation and redevelopment. Though it is not always possible, it helps to know site reuse options early in the process to inform clean-up decisions and determine the appropriate level of work needed in each stage of the assessment, clean-up and redevelopment process.

The Management of Rungas Prime Industries Limited shall develop a strategy for managing the decommissioning process that serves his or her business needs. Remediation shall start with collection of soil and ground water samples to investigate and document any contamination. Next, a plan for clean-up is developed and once approved by Federal Ministry of Environment.

0.22 CONCLUSION AND RECOMMENDATIONS

The Environmental & Social Impact Assessment (ESIA) for the proposed Type 3 Composite LPG Cylinder Manufacturing Plant was carried out in accordance with the Occupational Health, Safety and Environmental local, national, and international standards, using a multi- disciplinary team. In undertaking the ESIA study, a holistic approach was used whereby Project proponent, the Landowners, residents, and the Federal Ministry of Environment were involved. The significance of the impacts was duly assessed through standard field and laboratory methodologies, predictive modelling as well as desk reviews.

This ESIA report includes a draft Environmental & Social Management Plan that will ensure and guarantee minimal adverse effects of the project on the environment. The implementation of the project will significantly open the areas for sustainable development. The project will assist to enhancing building and infrastructural development, boosting employment, and as well as improving the living standard of the people.

The ESIA has demonstrated that the overall impacts associated with the project can be managed within reasonable and acceptable limits by applying all identified mitigation measures contained in this report. In consideration of the above therefore, there is no major environmental issue to impede the development of the proposed project, which is designed to improve the LPG supply chain.

It is therefore recommended that the project proponent implement the mitigation measures and recommendations stated in the ESIA report.

CHAPTER ONE

INTRODUCTION

1.0 BACKGROUND INFORMATION

Nigeria has a population of 190 million based on the last population census. It is worthy to note that only 1.8 million people of the entire population currently use Liquefied Petroleum Gas (LPG) and there are over 3 million old and unsafe cylinders currently in circulation. The 2014 global market evaluation of LPG was about $236.8 billion and is expected to grow by over $41.2 billion during the period of 2019- 2023. The LPG industry is worth over $10 billion and is still expanding due to the number of refineries that are coming on stream across Nigeria – this will increase the quantity of LPG in the market and will need to be supported by cylinder production and LPG facilities. Total supply volume for the domestic market from 2017: 708,000 MT; NLNG forecast that domestic LPG consumption will grow to 1.7million tons per annum by 2020. LPG can be used for the following applications: Cooking, Autogas for cars and vehicles, Agriculture to power machinery, Gas to power. All these applications need cylinders and storage facilities to ensure the safe use of the gaseous fuel. Cylinders are crucial and integral to the saturation policy of LPG in Nigeria for storage facilities to ensure the safe use of the gaseous fuel.

Rungas Prime Industries Limited is a dynamic and integrated manufacturing company whose mission is to provide increased accessibility through its product offerings of composite LPG cylinders and other advanced LPG infrastructures that are enhanced with state -of -the- art- technology to promote and ensure the widespread saturation and use of LPG (a cleaner fuel) in all homes and commercial establishments across the continent of Africa starting with Nigeria. Through this project there will be a widespread of the distribution of LPG Type 3 Composite gas cylinders leading to an extensive use of LPG in almost all homes in Nigeria which will reduce the emission of greenhouse gases capable of causing environmental degradation.

The Federal Government has a national drive-National Liquefied Petroleum Gas Expansion Implementation Plan, to increase the usage of LPG in Nigeria and also ensure that the facilities needed to facilitate the easy use of the cleaner fuel is readily and abundantly available. The Government is aiming to ensure that over 4 million homes within the next two years utilize LPG, being a cleaner fuel and aims at furthering this plan via investing and facilitating local gas cylinder manufacturing. In addition, the Government is looking at 100% of production of gas cylinders in the country within five years. To ensure the desired saturation of cylinders within Nigeria it is imperative that the scheme is backed by the Federal Government and NCDMB.

In compliance with the Environmental Impact Assessment Act CAP E12 LFN 2004, and due to the fact that the proposed project activities will have some interactive influences with the environment, there is need to conduct an Environmental Impact Assessment studies. Consequent upon the EIA application to FMENV, Rungas Prime Industries Limited has been requested by Federal Ministry of Environment (FMENV) to conduct a desktop study for the EIA of the type 3 Composite LPG cylinder manufacturing plant in Polaku, Yenagoa, Bayelsa State.

1.1 THE PROPONENT

The project proponent is **Rungas Prime Industries Limited.** Rungas Prime Industries Limited is a dynamic and integrated manufacturing company whose mission is to provide increased accessibility through its product offerings of composite LPG cylinders and other advanced LPG infrastructures that are enhanced with state-of-the-art technology to promote and ensure the widespread saturation and use of LPG (a cleaner fuel) in all homes and commercial establishments across the continent of Africa starting with Nigeria.

1.2 THE PROPOSED PROJECT LOCATION

The proposed project is located within the following GPS coordinates (UTM) represented on the table (1.0) below. The site is accessed through the bitumen tarred Polaku-Igbogene road, while access is into the site is through untarred stone-base earth road. The project is located within Polaku community in Yenagoa Local Government Area of Bayelsa State.

TABLE: 1.0 GPS COORDINATES OF THE PROPOSED PROJECT LOCATION

Boundary	**DD Latitude:**	**DD Longitude:**	**UTM E: (m.)**	**UTM N: (m.)**
Rungas gate 1	5.031936	6.289816	199544.567	556697.175
Rungas gate 2	5.032019	6.28995	199559.476	556706.277
Boundary B	5.030513	6.291359	199715.149	556539.074
Boundary C	5.028726	6.289157	199469.956	556342.282
Boundary D	5.029415	6.286173	199139.113	556419.862
Boundary E	5.030311	6.286357	199159.944	556519.021
Boundary F	5.030896	6.288158	199360.077	556582.849
Boundary G	5.030908	6.288388	199385.567	556584.125
Boundary H	5.030956	6.288626	199412.025	556589.281
Boundary I	5.03105	6.288814	199432.919	556599.625
Boundary J	5.031176	6.289136	199468.71	556613.436
Boundary K	5.03147	6.289117	199466.703	556645.965

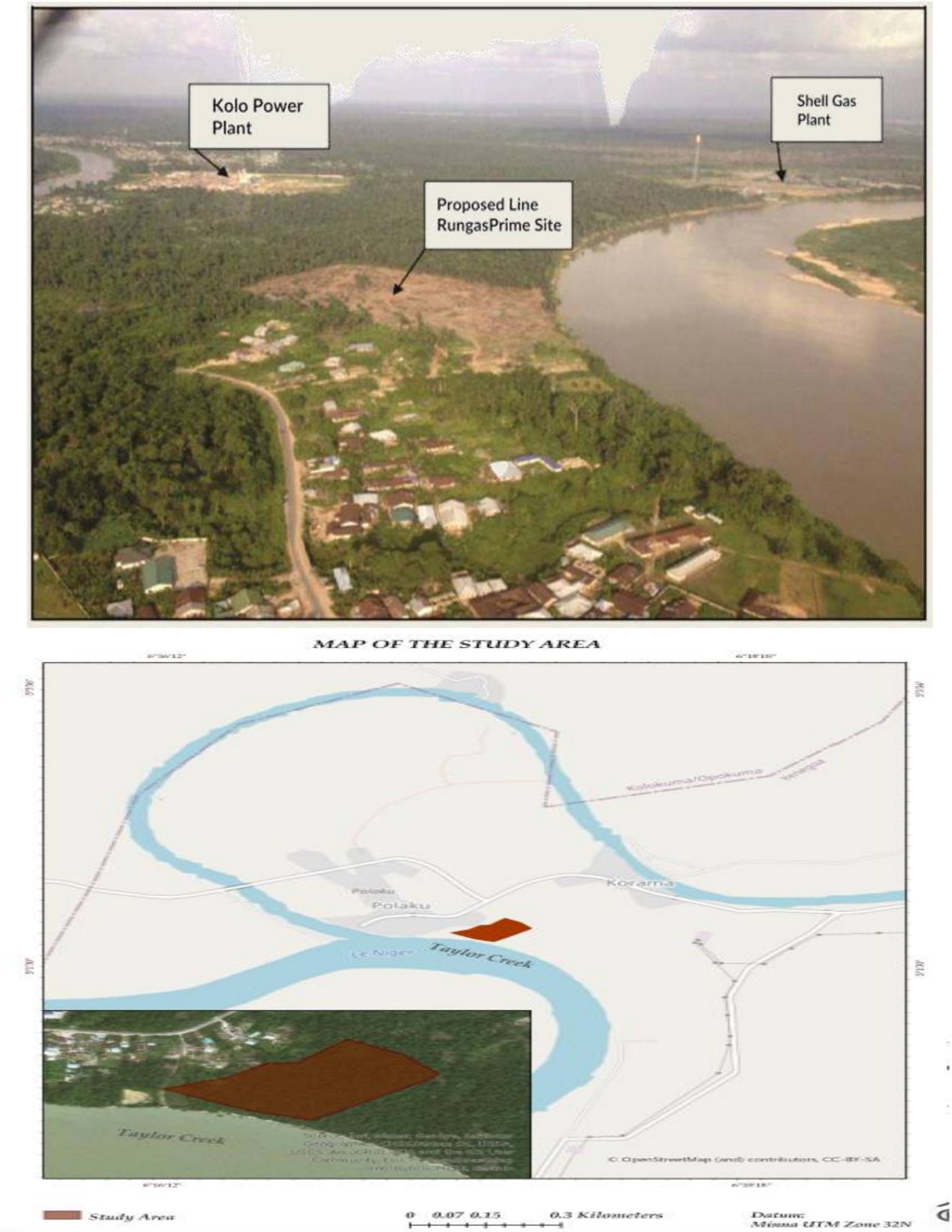

FIG. 1.0: PROPOSED PROJECT LOCATION

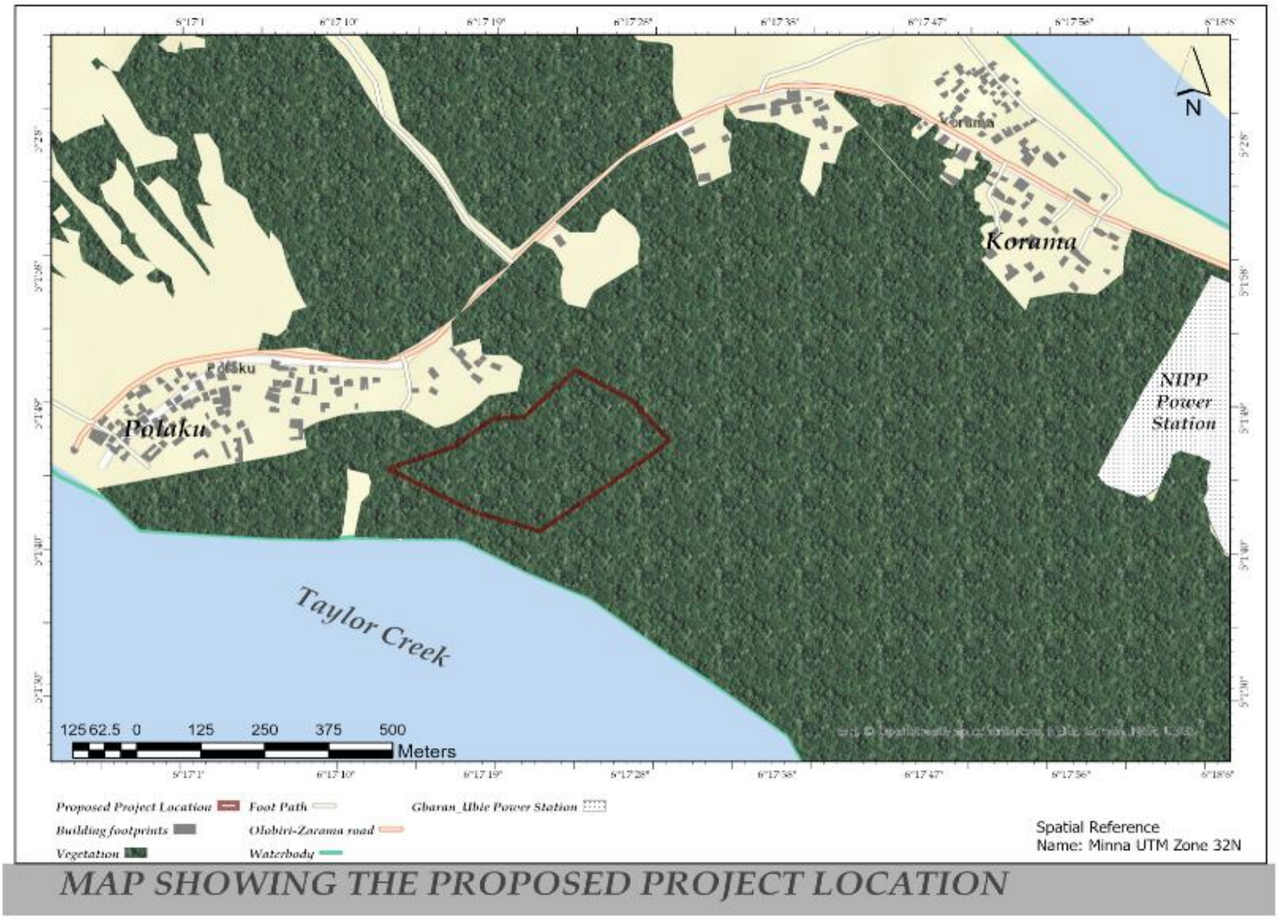

FIG. 1.1: PROPOSED PROJECT LOCATION

1.3 TERMS OF REFERENCE

The Terms of Reference (TOR) for this assessment shall be based on the consideration of the principal secondary afforestation /environmental elements within the proposed project area. These include:

- Existing vegetation or wildlife
- Other natural physical environment (air, water, soil), as well as principal physical features like topography, geology, drainage.
- Manmade physical environment along the corridor of the proposed project area e.g. buildings, cultural facilities, schools, hospitals, electricity poles/line, communication lines and such other public infrastructure.
- Human health and socio-economic of the communities along the corridors including culture.
- Aesthetic value of the environment.

- The study shall cover all aspects of preparatory and operational phases of the project; focusing on evolution and interpretation of environmental impacts of the project by carrying out the following.
- Generate baseline data of the existing ecology and socio economy of the proposed project areas.
- Identify, evaluate, prediction all impacts of the project on the environment including, health, security and safety.
- Development of a workable control and monitoring programmes and strategies to enhance the quality, beauty and aesthetics of the proposed project.
- Mitigation and amelioration of significant adverse impacts that the project shall have on the environment including traffic and human control.
- Development of environmental management systems including plans and procedures for effective management of the project at completion in terms of waste management (solid, liquid and air).
- Identify adverse action or inaction of project designers, engineers, monitors and the impacts of such actions on the project and the environment.
- Predicting potential impacts of all activities
- Recommendations on mitigating measures
- Monitoring, EMS and plan of action
- Submission of written report to the proponents and the authorities.
- Approval of the ESIA study report from the environmental authorities.

1.4 ESIA OBJECTIVES AND APPROACH

The scope of the proposed ESIA is described in the Terms of Reference which has been designed to assess the potential impacts (both negative and positive) from the proposed Type 3 Composite LPG manufacturing processes as well as to provide necessary mitigation measures and management plan to effectively manage the impacts and monitor the implementation of the management activities.

The basic objective of the ESIA study is to:

- collect baseline environmental components for the proposed manufacturing plant;
- assess, evaluate and predict the potential impacts of the field development project activities and their significance on the identified environmental sensitivities;
- review and update the baseline information of the area in line with the project scope;

- assess analysis of alternatives towards minimizing the environmental and social impacts and costs;
- assess and evaluate the requirements of environmental enhancement through ensuring proper consultation with the communities; and
- prepare Environment Management Plan (EMP) considering the input of public consultation, analysis of alternatives and impact assessment of the project.

1.5 ENVIRONMENTAL SCREENING AND SCOPING

Project screening of ESIA is the first step in the initial assessment of the possible environmental impacts of the proposed project. The purpose of the project screening is to ascertain if the proposed project requires an ESIA through the elimination of irrelevant environmental issues and focusing on potentially significant issues at the planning and design stages. The representatives of the Federal Ministry of Environment (FMENV) attended the site verification and scoping workshop. The scope of screening study included:

- consideration of bio-physical, socio-economic and health issues, environmental sensitive area and the relevant legislative framework; and,
- consultation with key decision-makers and experts to identify key issues.

The classification of EIA of Nigeria is given in Figure 1.2.

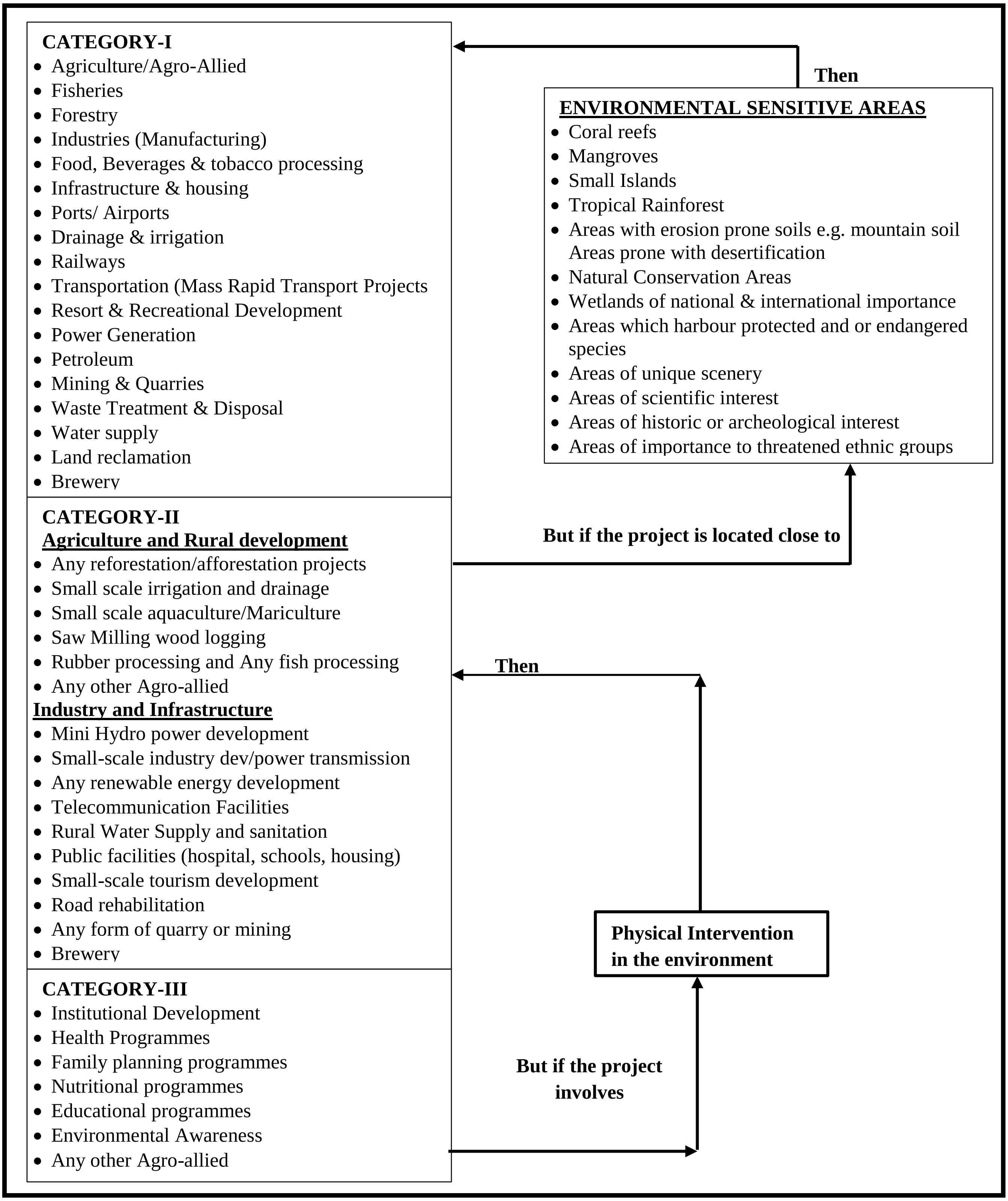

FIGURE 1.2: EIA CLASSIFICATION OF VARIOUS PROJECT SECTORS IN NIGERIA

Environmental issues are of concern to the Nigerian Government since 1988. The Federal Military Government created the Federal Environmental Protection Agency (FEPA) by Decree No 58 of 1988, and then formalized its functions by Decree No 59 in 1992. The two documents became known as the FEPA Act.

According to FEPA, developmental projects in Nigeria are divided into three categories namely Category-I, Category-II and Category-III. The projects falling under such project categories are shown in Figure 1.2.

- Category I projects will require a full Environmental Impact Assessment (EIA).
- Category II projects may require only a partial EIA, which will focus on mitigation and Environmental planning measures, unless the project is located near an environmentally sensitive area--in which case a full EIA is required.
- Category III projects are considered to have “essentially beneficial impacts” on the environment, for which the Federal Ministry of the Environment will prepare an Environmental Impact Statement.

The proposed project falls under industry which is further categorized as **Category-I** and hence a- one- season ESIA study is required to be undertaken.

1.6 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDIES PREMISES

The key Environmental Impact Assessment (EIA) principles were established to provide general guidance, framework, and a commitment to standards, which are acceptable nationally and internationally. In line with this, the principles will be retained in this study and where necessary variations are allowed with evidence. Additional procedures, commitments and understanding necessary to resolve environmental impact, were developed and adopted through the Environmental Impact Assessment (EIA) process. The premises are as follows:

- **Rungas Prime Industries Limited** recognizes the Federal Ministry of Environment, State Ministry of Environment, and other States Environmental Regulatory Agencies and laws operating both nationally and internationally. Furthermore, the project will adopt the best option relevant to the local circumstances and situations.
- The project has been designed to comply with these local and national laws, in conjunction with all the international protocols, agreements and conventions.
- During this Environmental & Social Impact Assessment Study all the understandings arrived at during consultations with the Federal Ministry of

Environment and the issues raised by the indigene during the stakeholder's process were without prejudiced considered.

- Consultations have and will continue to be held with all stakeholders at various levels (State and Local Governments) together with Polaku community. Consultation meetings shall be maintained on a mutually agreed basis during the entire project phases.
- During this ESIA an Environmental & Social Management Plan (ESMP) has been developed as part of the ESIA process. The implementation of the plan will be the responsibility of Rungas Prime Industries Limited.

1.7 LEGAL AND ADMINISTRATIVE FRAMEWORK

There are existing international, federal /state statutory regulations requiring Development Permit for any new project and those that require the proponent of a major/mandatory project to submit an Environmental Impact Assessment study report prior to the execution. The Project area is subject to many other specific laws, guidelines and standards that ensure compliance with environmental pollution abatement in facilities that generate wastes, groundwater protection and surface impoundment, health and safety, and hazardous substances. Rungas Prime Industries Limited believes and adheres to the principle of sustainable development. Rungas Prime Industries Limited shall therefore conduct the project in line with stipulated local, national, regional and international statutes, guidelines, standards and specification for the protection of the environment. There are both international and national/local regulations/legislation summarized below:

1.7.1 WORLD BANK GUIDELINES ON ENVIRONMENTAL ASSESSMENT (EA) 1991.

The World Bank has set up environmental assessment standards that must be fulfilled by any project proponent before they can access financial assistance in form of loan. In line with the foregoing; the World Bank requires an EIA report as a prerequisite for the borrower to be granted approval for such loans. The EIA report normally forms part of the feasibility study of the project. Projects are categorized based on their EIA requirements and is very much similar to that of FEPA. The details of World Bank's EIA procedures and guidelines are published in the Bank's EA Source Book vols. I - III of 1991. Potential issues considered for EA in the upstream oil and gas industry include the following:

- Biological Diversity
- Coastal and Marine Resources Management
- Cultural Properties
- Hazardous and Toxic Materials and

- International waterways.

1.7.2 INTERNATIONAL UNION FOR CONSERVATION OF NATURE & NATURAL RESOURCES (IUCN) GUIDELINES.

The World Conservation Union of Nature & natural Resources (IUCN) in conjunction with the oil Industry International Exploration and Production forum (E & P Forum) have guidelines, which contain internationally acceptable practices and standards for oil and gas exploration and production. These guidelines present practical measures to conserve wetlands and enhance protection of aquatic ecosystem during oil and gas E & P activities.

The general discussions are on Environmental Profile activity, preliminary Environment Impact Assessment, Environmental Impact Assessment (EIA), Environmental Management, Environmental Monitoring, and Environmental Audit. From the guidelines, it is recommended that a Preliminary EIA report be prepared before any activity commences at the project site; and it is to build on the findings of the environmental profile and examine sensitive issue in details.

1.7.3 CONVENTION ON BIOLOGICAL DIVERSITY

The objectives of this Convention encompass the conservation of biological diversity, through the sustainable use of environmental components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

1.7.4 BASEL CONVENTION ON THE CONTROL OF TRANS-BOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL

The convention focuses attention on the hazards of the generation and disposal of hazardous wastes. The convention defines the wastes to be regulated and control their trans-boundary movement to protect human and environmental health against their adverse effects.

1.7.5 UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (1992)

Climate change is a global environmental issue and it therefore requires concerted efforts of all the nations. To achieve sustainable social and economic development, energy consumption in the developing nations needs to grow taking into account the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general. This also includes the application of new technologies on terms which make such an application economically and socially beneficial, determined to protect the climate system for present and future generations. The proposed project has incorporated strategies into its manufacturing technology and processes to improve energy consumption and to ensure efficiency.

1.7.6 LAND USE ACT CAP 202 LFN 1990

The Land Use Act was promulgated in 1978 with commencement date of March 29, 1978 now Land Use Act Cap 202 LFN 1990. It vests all land in each State of the Federation (except land already vested in the Federal Government of Nigeria 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 confers similar powers regarding non-urban areas on the local governments in such cases. The governor of a State can revoke a right of occupancy for overriding public interest (e.g. new project development purposes). The following surface rights are permitted under Section 51 of the Land Use Act:

- fishing rights
- buildings and other structures, juju shrines, objects of worship
- farms, cultivated crops, economic trees, projects
- Loss of use of the land.

1.7.7 FEDERAL MINISTRY OF ENVIRONMENT (FMENV)

The Federal Ministry of Environment is now the apex institution in Nigeria charged with the overall responsibility for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria’s natural resources. The Ministry grants permits for environmental and laboratory consultancies and must approve an Environmental Impact Assessment (EIA) study of a major development activity before the proponent can implement execution.

1.7.8 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ACT. CAP E12, LFN 2004.

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

This process involves the undertaking of mandatory study by a review panel and the preparation of a mandatory Environmental Impact Assessment (EIA) report.

1.7.9 REGULATIONS GAZETTED AS SUPPLEMENTARY TO NESREA ACT

- National Environmental (Soil Erosion and Flood Control) Regulations, S. I. No. 12 of 2011
- National Environmental (Surface and Groundwater Quality Control) Regulations, S. I. No. 22 of 2011
- National Environmental (Protection of Wetlands, River Banks and Lake Shores) Regulations, S. I. No. 26 of 2009:
- National Environmental (Watershed, Mountainous, Hilly and Catchments Areas protection) Regulations, S. I. No. 27 of 2009
- National Environmental (Sanitation and Wastes Control) Regulations, S. I. No. 28 of 2009
- National Environmental (Noise Standards and Control) Regulations, S. I. No. 35 of 2009
- National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, S. I. No. 15 of 2011
- National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. No. 16 of 2011
- National Environmental (Construction Sector) Regulations, S. I. No. 19 of 2011

1.7.10 THE MINERAL OIL (SAFETY) ACT CAP 350 LFN 1990

This Act is promulgated to ensure that project proponents design methods to address the safety of employees in the oil & gas sector. Sections 37 and 40 of the Mineral Oil (Safety) Act CAP 350 LFN 1990 require provision of Personal Protective Equipment (PPE) and the safety measures for workers in drilling and production operation in accordance with international standards.

1.7.11 NATIONAL INLAND WATERWAYS AUTHORITY ACT NO 13 OF 1997

This Act established the National Inland Waterways Authority 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 erection of permanent structures within the right-of-way or diversion of water from a declared waterway.

1.7.12 FORESTRY LAW CAP 52, 1994

Conservation of the natural resources is key to sustainable development and to avoid extinction of some species of plants and animals; and it was pursuant to this that this law was promulgated. The Forestry law prohibits any act that may lead to the destruction of or cause injuries to any forest produce, forest growth or forest property. The law clearly states the administrative framework for the management, utilization and protection of forestry resources in Nigeria.

1.7.13 TERRITORIAL WATERS ACT CAP 428 LFN 1990

The territorial waters of Nigeria shall for all purpose include every part of the open sea within twelve nautical miles of the coast of Nigeria (measured from low water mark) or of the seaward limits of inland waters. Any act or omission which:

- is committed within the territorial waters in Nigeria, whether by a citizen of Nigeria or a foreigner; and
- would, if committed in any part of Nigeria, constitute an offence under the law in force in that part, shall be an offence under that law and the person who committed it may, subject to section 3 of this Act, be arrested, tried and punished for it as if he had committed it in that part of Nigeria

1.7.13.1 WATER RESOURCES ACT CAP W2 LFN 2004

The Water Resources Act vests the right to the use and control of all surface and groundwater and of all water together with the bed and banks in any watercourse affecting more than one state in the Government of the Federation. However, the Act essentially preserves existing rights, including customary rights, provided they are for domestic use, watering of livestock and personal irrigation schemes. A proviso to section 1(1) states that the subsection shall not be deemed to infringe or to constitute a compulsory right over or interest in property. Apparently, the idea is to separate rights over water resources from other rights in property.

1.7.14 THE DEPARTMENT OF PETROLEUM RESOURCES (DPR) ENVIRONMENTAL GUIDELINES & STANDARDS FOR PETROLEUM INDUSTRY IN NIGERIA 2018.

The Department of Petroleum Resources (DPR) Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) 2018 was enacted to regulate the Nigerian Petroleum Industry. It was made mandatory in Part viii (A) sections 1.4.3(ii) and 1.6 for project proponents to prepare Environmental Impact

Assessment (EIA) reports for all developmental projects within the petroleum industry.

1.7.15 BAYELSA STATE ENVIRONMENTAL PROTECTION AGENCY

The Edicts setting up the State Environmental Protection Agency (SEPA) outlined the primary responsibilities of the agency, which is to protect and develop the general environment of the various States to be affected by any existing production facility through the conduct of Environmental Audit report (EAR). The Environmental Impact Assessment (EIA) Act No 86 of 1992 now Environmental Impact Assessment (EIA) ACT. CAP E12, LFN 2004 is the substantive law that regulates the citing of projects that infringe on environmental elements in Nigeria, the State Ministry of Environment in which each project is located has a major role to play in the overall Environmental Impact Assessment (EIA) process as a matter of law. Some of the Bayelsa State Ministry of Environment's responsibilities are listed below:

- Establishment and implementation of the numerous strategies of the National Policy on Environment towards achieving sustainable development;
- Implementation of existing environmental edicts on activities related to the environment.
- Monitoring the implementation of Environmental Audit Report (EAR) guidelines and procedure on all developed policies and projects within the State.
- Overall responsibility for all environmental issues in the state

A list of Nigerian laws and regulations enacted at various times since 1963, that are concerned with environmental protection are tabulated hereunder. There are specific Nigerian Government Laws and regulation related to environmental protection, conservation and safety in Nigeria includes but not limited to the following:

1. Federal Environmental Protection Agency Decree No 58 1988
2. Petroleum Regulations 1967
3. Petroleum Act. 1969
4. Employees Compensation Act 2010.
5. Mineral Oils (Safety) Regulations 1963
6. Factories Act 2004
7. Harmful Waste (Special Criminal Provisions, Etc.) Act 1988
8. Electricity Supply Regulations (Including Electrical Supply Act.1929) 1979

9. Gas Industry in Nigeria, Draft Regulations 1989
10. Director of Petroleum and Mineral Resources Environmental Guidelines and Standards for the Petroleum Industry in Nigeria 1991
11. S.1.8: National Environmental Protection (Effluent Limitation) Regulations 1991
12. S.1.9: national Environmental Protection (Pollution Abattement in Industries and Facilities Generating Waste) Regulations 1991
13. Federal Environmental Protection Agency Interim Guidelines and Standards for Environmental Pollution Control in Nigeria 1991
14. Environmental Impact Assessment Decree No. 86 1992
15. S.1.14 Oil and Gas Pipelines Regulations 1995
16. Endangered Species Act No. 11 1985
17. Bayelsa State Environmental and Development Planning Authority Law 1998;
18. Environmental Sanitation Law 1984 (Law No.6 of 1984)
19. Refuse Collection and Disposal Law 1991 (Law 8 of 1991)
20. Bayelsa State Pollution Compensation Tax Law 1998;
21. Bayelsa State Forestry Law 1998.

1.8 SCOPE OF WORK

The scope of work for this ESIA involved an extensive literature review and a comprehensive field data gathering exercise which characterized the study area. Specifically, the work scope entailed:

- Review of national and international environmental regulations guiding the project construction activities to be carried out as well as consultation with relevant stakeholders.
- Description of the Project

This ESIA documented a clear description of the proposed project in a manner that facilitated the comprehension of all stakeholders. The description included but not limited to the following:

- Construction/installation of facilities and equipment;
- Operations and maintenance of the factory and ancillary facilities;
- Assessment of project and environmental risks and hazards;
- Contingency plans and emergency response philosophies;
- Project risk and hazard prevention philosophy; and
- Definition of the project schedule.

Description of Project Environment/ Baseline data collection and Assessment

This ESIA report is comprehensive and encompassed scientific description of the ecological and socio-economic baseline conditions of the proposed project area; which included the following:

Climate

- Rainfall
- Humidity
- Wind speed and direction
- Temperature

Air Quality/Noise

- Localized ambient air pollutants
- Ambient noise levels
- Noise sources
- Proximity of human and ecological habitats to noise sources

Aquatic Systems

- Surface water system identification and characterization
- Qualitative and quantitative description of plankton and fisheries
- Aquatic ecosystem sensitivity description
- Assessment of the Economic importance of aquatic ecosystems in the study area

Soil /Land-Use and Agriculture

- Soil physico-chemistry
- Soil microbiology
- Soil morphological characterization
- Land use description
- Agriculture/vegetation

Ecology

- Species checklist
- Characterization of plant and animal species found in the study area
- Habitat description
- Endangered species identification
- Recommend that existing vegetation be maintained where practicable.

Socio-economics

- Settlements and man-made features around the site
- Resettlement Plan (if any)
- Economic and historical sites (shrines, sacred forest)
- Population distribution around the study area

- Determination of Income distribution in the study area through questionnaire administration
- Existing recreational facilities within the project area
- Social organizations and institutions within the project area
- Occupation and employment structure
- Cultural and religious practices
- Host community's health status and health facilities
- Project health risks
- Community's needs and concerns regarding the project.

Waste/ Environmental Management

- Sources of Waste generation at all stages of the project
- Adequacy of Storage and disposal systems proposed
- Waste management plan
- Pollution control at all stages of the project
- Social and environmental monitoring program that would be put in place for the project.

Assessment of Associated and potential Impacts

The identification and evaluation of associated and potential impacts was carried out based on the following:

- Identification of impact sources;
- Identification of impact indicators;
- Prediction of impact magnitude - empirical worst-case scenario;
- Evaluation of importance of environmental components – consensus of opinions;
- Evaluation of impacts –based on worst case scenario
- Development of an Environmental Management Plan
- Preparation of Draft and Final EIA report following the guidelines and procedure of Ministry of Environment.

These focused items were addressed within the scope of the ESIA report and it is consistent with the Federal & State Ministry of Environment guidelines.

1.9 STUDY APPROACH AND METHODOLOGY

The ESIA study was undertaken in accordance with Federal Ministry of Environment standards and the World Bank standards. The distinct phases of the study included:

TABLE 1.2: DISTINCT PHASES OF THE ESIA STUDY

Activities	Description of Items
Activity-1	Literature review
Activity-2	Project understanding and Institutional Consultation with Federal & Bayelsa State Ministry of Environment and Reconnaissance Survey
Activity-3	Site verification by Federal Ministry of Environment
Activity-4	Collection of necessary secondary information and Monitoring

Activity-1 Literature review

Review of Feasibility study report, Existing Laws and Regulation documents, decrees, acts, policies and guidelines for Federal & Bayelsa State.

Activity-2 Project understanding and Institutional Consultation

The study team conducted series of site visits to understand the site geological, ecological, physical features through reconnaissance survey. The team discussed the following:

- ESIA processes;
- Is there any kind of protected area (like National Park/Wildlife sanctuary) in the project areas;
- Project implementation framework

Activity-3 Site Verification

As per the ESIA clearance process in Federal Ministry of Environment nominated some of its officers for the Site verification to the project site. During the verification exercise; discussion was also held regarding the number of environmental monitoring stations as well as existence of any kind of protected areas within the project area. Further, during the verification it has also been observed that the project is not being used by any kind of wild animal as a migratory route. The site verification was carried out on the 27th of August 2020. The site verification photographs are shown below:

PLATE 1.0: SITE VERIFICATION: From left: Mrs Rita Tuomokeme (FMENV Abuja Rep); Mr Aleibiri Amatari (Rep of Commissioner of Bayelsa Min of Env); Mr Omovoh Gift Ochonogor (FMENV Abuja Rep), Mr Inoyo John James (Director, FMENV Regional Office, Bayelsa State); Mr Lucky Oderhohwo (MD/CEO, Rholuck Services Nigeria Ltd).

PLATE 1.2: REPRESENTATIVES OF FMENV, PROJECT PROPONENT & RHOLUCK SERVICES NIGERIA LTD).

Activity-4 Collection of Necessary Secondary Information and Monitoring

After the completion of site verification by the Federal Ministry of Environment the necessary primary and secondary data collection initiated on the 28th August 2020. The data collected during this time included:

- Physical chemical and microbial analysis for surface water and ground water;
- Physical and chemical analysis for soil samples including soil microbiology;
- Ambient air qualities;
- Noise qualities;
- Ecology and vegetation study;
- Geology/Geotechnical Study;
- Socio-Economic and Health impacts study

PLATE 1.3: REPRESENTATIVES OF FMENV, CONSULTANT DURING DATA GATHERING

PLATE1.4:REPRESENTATIVE OF FMENV, CONSULTANT & LAB PERSONNEL DURING ANALYSIS OF SAMPLES

1.10 EQUATOR PRINCIPLES (EPS) AND IFC PERFORMANCE STANDARDS

The Equator Principles (EPs) is a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. The EPs, based on the IFC Performance Standards on social and environmental sustainability and on the World Bank Group Environmental, Health, and Safety Guidelines (EHS Guidelines), are intended to serve as a common baseline and framework for the implementation by each Equator Principles Financial Institutions (EPFI). The applicability of EP to the project has been outlined below.

TABLE 1.3: APPLICATION OF EQUATOR PRINCIPLES

Equator Principles	Requirements	Project Information/ Application
Principle 1: Review and Categorization	As the project is seeking financing from EPFIs, the project has to be categorized based on the magnitude of its potential impacts and risks in accordance with the environmental and social screening criteria of IFC.	Proposed Type 3 composite LPG cylinder production project is identified as a Category "1" project (A-One-season data gathering).
Principle 2: Social and Environmental Assessment	An Environmental and Social Assessment has to be carried out for the project that addresses relevant social and environmental impacts and risks of the proposed project and also propose mitigation and management measures relevant and appropriate to the nature and scale of the proposed project.	The social and environmental assessment and its management measures are reported in chapters 5 to chapter 8 in the present report including risk assessment.
Principle 3: Applicable Social and Environmental Standards	Nigeria being a non-OECD (Organization for Economic Cooperation Development) country, the IFC performance standards (under exhibit III), General EHS Guidelines and the sector specific EHS Guidelines (Exhibit IV – General EHS guidelines and will be applicable	The compliance with IFC standards is reported in chapter-8.
Principle 4: Action Plan and Management System	The action plan will describe and prioritize the actions needed to implement mitigation measures, corrective actions and monitoring	The action plan and management measures are given in chapter-9.

Equator Principles	Requirements	Project Information/ Application
	measures necessary to manage the impacts and risks identified in the Assessment	
Principle 5: Consultation and Disclosure	The project affected communities are required to be consulted in a structured and culturally appropriate manner.	Public Consultation conducted during the baseline survey work.
Principle 6: Grievance Mechanism	Rungas Prime Industries Limited is required to establish a grievance mechanism as part of the management system	The HSE team of Rungas Prime Industries Limited. will take care of grievances raised verbally or in written manner.
Principle 7: Independent Review	An independent social or environmental expert, not directly associated with Rungas Prime Industries Limited is required to review the Assessment, action plans and consultation process documentation in order to assist EPFI's due diligence, and assess Equator Principles compliance.	As part of the loan approval for the project the respective EPFI may appoint an independent social or environmental expert for review of ESIA/ESMP report.
Principle 8: Covenants	The covenants would be a part of the contract documents between Rungas Prime Industries Limited & financing agency as well as contractors and technology suppliers based on the following: a) to comply with all relevant host country social and environmental laws, regulations and permits in all material respects; b) to comply with the action plans (where applicable) during the construction and operation of the project in all material respects c) to provide periodic reports in a format agreed with EPFIs (with the frequency of these reports proportionate to the severity of impacts, or as required by law, but	E&S Covenants shall be embedded within the contracts drawn between Rungas Prime Industries Limited and the contractors hired for construction activities and technology providers and waste handlers. Periodic reporting to the project developers will have to be carried out by the contractors.

Equator Principles	Requirements	Project Information/ Application
	not less than annually), prepared by in-house staff or third-party experts, that i) document compliance with the action plans (where applicable), and ii) provide representation of compliance with relevant local, State and host country social and environmental laws, regulations and permits (where applicable) d) to decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan	
Principle 9: Independent Monitoring and Reporting	EPFIs will, for all Category A Projects, and as appropriate, for Category 1 projects, require appointment of an independent environmental and/or social expert, or require that the borrower retain qualified and experienced external experts to verify its monitoring information which would be shared with EPFIs.	The project falls under category-1 and the periodic reporting mechanism will be done as agreed between EPFI and Rungas Prime Industries Limited. The project proponent shall appoint independent Environmental Consultant to monitor the environmental component throughout the project execution.
Principle 10: EPFI Reporting	This shall be prepared by the EPFI	Based on the assessment and monitoring reports submitted by independent agencies the EPFI will report the findings publicly at least once a year

1.11 IFC PERFORMANCE STANDARDS

IFC Performance Standards (revised applicable from January 2012) define clients' roles and responsibilities for managing projects and the requirements for receiving and retaining financing from EPFI's. The applicability of IFC Performance Standards to the project is outlined in **Table 4.0**.

TABLE 1.4: APPLICATION OF IFC PERFORMANCE STANDARDS TO THE PROJECT

IFC Performance Standards	Requirements	Project Information/ Application
Performance Standard 1: Social & Environmental Assessment & Management System	The project should have a social and environmental management system that incorporates the following: (i) policy; (ii) identification of risks and impacts; (iii) management programs; (iv) organizational capacity and competency; (v) emergency preparedness and response; (vi) stakeholder engagement; and (vii) monitoring and review.	This Performance Standard is applicable to the Project. Details will be given in table 8.9 in chapter-8.
Performance Standard 2: Labor and Working conditions	Rungas Prime Industries Limited requires to follow requirements on: (i) Working conditions & management of worker relationship (human resource Conditions policy, working conditions, terms of employment, workers organizations, non-discrimination equal opportunity, retrenchment, grievance mechanism); (ii) Protecting work force (not engaging child labour and forced labour); (iii) Occupational health and safety; (iv) Workers engaged by third parties; & (v) Adverse impacts related to supply chain.	This Performance Standard is applicable to the Project addressed in table 8.9 as well as the environment management plan in chapter 9.
Performance Standard 3: Pollution Prevention and Abatement	Rungas Prime Industries Limited requires to consider: i. Sustainable resource utilization (water consumption); ii. Pollution prevention (wastes,	This Performance Standard is applicable to the Project and is addressed in table 8.1 in chapter 8.

IFC Performance Standards	Requirements	Project Information/ Application
	hazardous materials management, pesticide use and management)	
Performance Standard 4: Community Health, Safety and Security	Rungas Prime Industries Limited requires to follow requirements on: i. Infrastructure and equipment design and safety; ii. Hazardous materials management and safety; iii. Ecosystem services; iv. Community exposure to disease; v. Emergency preparedness and response; and vi. Security personnel.	This Performance Standard is applicable to the Project and is addressed in the management plan. Details will be given in chapter 9.
Performance Standard 5: Land Acquisition & Involuntary Resettlement	Specifies requirements on: i. Project design to avoid or minimize physical and/or economic displacement; ii. Compensation and benefits for displaced persons; iii. Community engagement; iv. Grievance mechanism; v. Resettlement and livelihood restoration planning and implementation; vi. Physical and economic displacement; vii. Private sector responsibilities under government-managed resettlement	The project does not involve private land acquisition and hence the impact from land acquisition. However involuntary resettlement would be involved.
Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management	Specifies requirements on: i. protection and conservation of biodiversity (modified, natural, critical habitat, legally protected and internationally recognized areas, invasive alien species); ii. management of ecosystem services; iii. sustainable management of natural resources; and iv. supply chain	The site has been selected on barren land with insignificant impact on biodiversity. Hence the project meets this performance standard.
Performance Standard 7: Indigenous	Specifies requirements on i. avoidance of adverse impacts; ii. participation and consent;	The project site alignment has been selected in such a fashion that there is no

IFC Performance Standards	Requirements	Project Information/ Application
People	iii. circumstances requiring free, prior, and informed consent; iv. mitigation and development benefits; and v. private sector responsibilities where government is responsible for managing indigenous people's issues	impact on families as it has been designated by Nigerian Content Dev. Management Board (NCDMB) as location for industrial hub.
Performance Standard 8: Cultural Heritage	Specifies requirements on: i. protection of cultural heritage in project design and execution (chance find procedures, consultation, community access, removal of replicable cultural heritage, removal of non-replicable cultural heritage, critical cultural heritage); and ii. project's use of cultural heritage	The project does not impact on any cultural property or structure of archaeological importance.

1.12 STRUCTURE OF THE ESIA REPORT

The structure of the ESIA report is as shown below:

- Chapter One – The chapter one contains the introduction; and it contains the background information, ESIA objectives, Legal/administrative framework, structure of the ESIA report.
- Chapter Two – This contains the Project Justification, and it emphasizes the proposed project background, project objectives, basis of the project, envisaged sustainability, and development options to be considered in the proposed project;
- Chapter Three- This chapter contains the project description, it describes the type of project, scope, location, material input/output and by-products, waste generation, technical layout and process, operation and maintenance, proposed project schedules;
- Chapter Four - Description of Existing Environment is contained in this chapter and it further provides every information on the precinct/baseline environmental conditions of the project area describing the physical, chemical, biological social, and health environment
- Chapter Five - Associated and Potential Environmental Impacts – emphasis is placed on the Associated and Potential Environmental Impacts of the proposed project;

- Chapter Six – Mitigation Measures/Alternatives – illustrates the mitigation options for the proposed project impacts;
- Chapter Seven - Environmental & Social Management Plan - presents the proposed plans for the social & environmental management;
- Chapter Eight - Decommissioning and Abandonment Plan defines the strategies to be adopted during decommissioning of the plant and provides remediation plans after decommissioning/abandonment.; and
- Chapter Nine - Conclusion and Recommendations: This chapter contains conclusion and recommendations based on data analysis and project implementation strategies.

CHAPTER TWO

PROJECT JUSTIFICATION

2.0 INTRODUCTION

The Federal Government has initiated national drive on Liquefied Petroleum Gas Expansion Implementation Plan, to increase the usage of LPG in Nigeria and also ensure that the facilities needed to facilitate the easy use of the cleaner fuel is readily and abundantly available. The Government is aiming to ensure that over 4 million homes within the next two years utilize LPG, being a cleaner fuel and aims on furthering this plan via investing and facilitating local gas cylinder manufacturing. It is in line with the federal Government drive to boost the national usage of natural gas that Rungas Prime Industries Limited has planned to establish Type 3 Composite LPG Cylinder manufacturing Plant. Rungas Prime Industries Limited is a dynamic and integrated manufacturing company whose mission is to provide increased accessibility through its product offerings of composite LPG cylinders and other advanced LPG infrastructures that are enhanced with state-of-the-art technology to promote and ensure the widespread saturation and use of LPG (a cleaner fuel) in all homes and commercial establishments across the continent of Africa starting with Nigeria. Through this project there will be a widespread of the distribution of LPG Type 3 Composite gas cylinders leading to an extensive use of LPG in almost all homes in Nigeria which will reduce the emission of greenhouse gases capable of causing environmental degradation.

In addition, the Government is looking at 100% of production of gas cylinders in the country within five years. To ensure the desired saturation of cylinders within Nigeria it is imperative that the scheme is backed by the Federal Government and NCDMB.

2.1 BENEFITS OF THE PROJECT

Rungas is a dynamic and integrated gas infrastructure company whose mission is to provide increased accessibility through its product offerings of composite LPG cylinders and other advanced LPG infrastructures that are enhanced with state-of-the-art technology to promote and ensure the widespread saturation and use of LPG (a cleaner fuel) in all homes and commercial establishments across the continent of Africa starting with Nigeria.

As a company, the project proponent has positioned herself across the entire LPG value chain of Nigeria in a bid to be able to provide the Nigeria “gas” industry with the much needed transformation and ultimately aid in the saturation and expansion of the use of LPG by providing the infrastructure required to support this growth but also ensure that LPG is made accessible and is in abundant supply for the populace of Nigeria.

2.1.1SOCIO-ECONOMIC BENEFITS

The project will serve as an important employment creation and will provide employment opportunity throughout the life span of the project. After construction, period the industrial and infrastructure development will provide enormous employment opportunities. The proposed type 3 composite LPG cylinder manufacturing plant will provide the following socio-economic benefits:

- enhance the accessibility the products;
- employment opportunities for the indigene;
- increase in social activities as personnel will be moving towards the area;
- more business opportunities will spring up within the host community; thereby increasing the employment opportunities and income of the indigene; and
- overall improvement in the quality of life for the lesser development areas in the neighbourhood.

2.1.2 ENVIRONMENTAL BENEFITS

- Reduction in air pollution, due to the use of natural gas in running the generators; and
- Reduction in the emission of greenhouse gases.

2.2 NEED FOR THE PROJECT

The Federal Government of Nigeria (FGN) is targeting astronomical increase in the supply of LPG to homes in Nigeria as a medium to drastically reduce gas flaring. To stem the tide in ensuring that over 4 million homes within the next two years utilize LPG, being a cleaner fuel and aims on furthering this plan via investing and facilitating local gas cylinder manufacturing. In furtherance to the Federal Government drive to boost the national usage of natural gas that Rungas Prime Industries Limited has planned to establish Type 3 Composite LPG Cylinder manufacturing Plant. In addition to the foregoing, the proposed composite type 3 LPG cylinder has a light weight when compared with existing steel cylinders which is prone to corrosion and explosion.

2.3 VALUE OF THE PROJECT

The value of the project is about ₦2.96 Billion. Rungas Prime will provide an equity contribution of ₦2 Billion for the development of the Project and a debt facility of

₦857.52 Million for equipment and inventory purchase; and to augment working capital for the project. Term loan of ₦394.49 Million and Overdraft of ₦463.03 Million. The debt investment would be repaid within five years of commencing operations.

2.3.1 PROJECT FINANCIAL FEASIBILITY

The financial feasibility of the proposed project is presented on the table 5.0.

TABLE 2.0: PROJECT FINANCIAL FEASIBILITY

Cost Lines	Type 3 - 12kg Unit Cost	% Distribution	Type 3 - 6kg Unit Cost	% Distribution.
Raw Material Cost Type 3	₦9,623.00	86%	₦6,639.71	81%
Payroll Expenses	₦172.20	2%	₦172.20	2%
Admin Cost	₦150.00	1%	₦150.00	2%
Power	₦337.08	3%	₦337.08	4%
Marketing and Promotional Expenses	₦4.50	0%	₦4.50	0%
Staff Training	₦12.50	0%	₦12.50	0%
Telephone & Other Communication Expenses	₦6.00	0%	₦6.00	0%
Legal and Other Professional Services	₦7.50	0%	₦7.50	0%
Business Travel and Local Transport	₦30.00	0%	₦30.00	0%
Repairs and Maintenance	₦22.50	0%	₦22.50	0%
Start-up Expense	₦0.00	0%	₦0.00	0%
Provisional for Stock loss/Write Offs	₦31.76	0%	₦31.76	0%
Corporate Social Responsibility (CSR)	₦4.25	0%	₦4.25	0%
Directors Expense	₦2.00	0%	₦2.00	0%
Depreciation and Amortization	₦745.65	7%	₦745.65	9%
Total Production Cost	**₦11,148.93**	**100%**	**₦8,165.65**	**100%**
Unit Sales Price	**₦17,364.38**	**56%**	**₦13,891.50**	**70%**

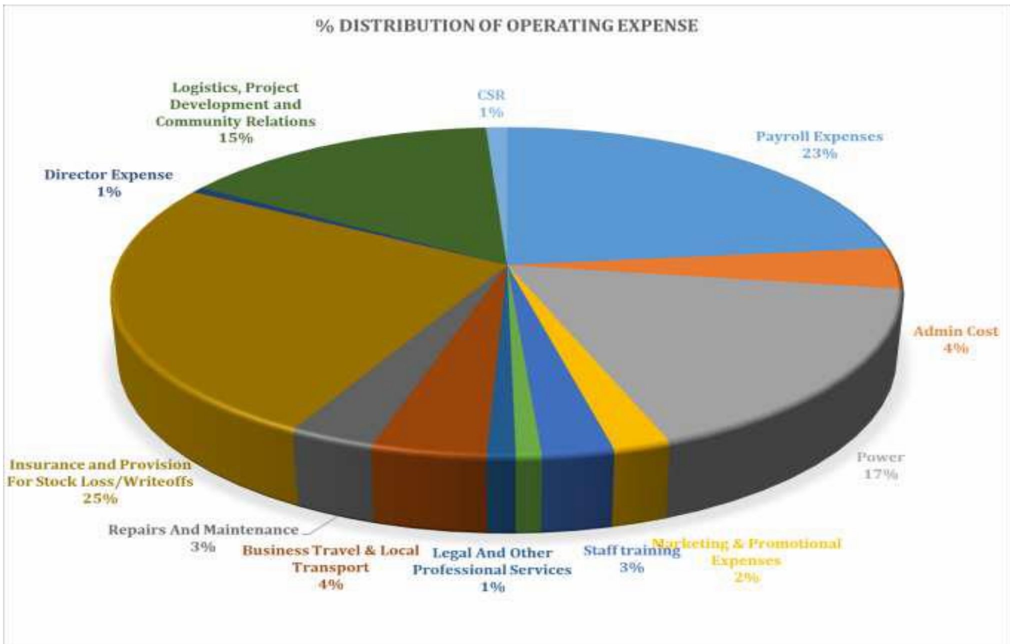

FIG 2.0: % DISTRIBUTION OF OPERATING EXPENSES (SOURCE: PROPONENT'S BUSINESS PLAN)

2.4 ENVISAGED SUSTAINABILITY

Rungas Prime Industries Limited has been in the business of distribution of composite LPG cylinder for decades and has acquired technical expertise in the proposed manufacturing plant. The Liquidified petroleum gas needed to run the manufacturing plant with be gotten from Shell gas plant at Gbaran within the State. Since the raw materials are within it will greatly improve the sustainability of the project and improve the economy of Nigeria. The proposed Type 3 Composite LPG manufacturing plant is expected to be sustained through proper inspection and routine maintenance of its facilities. The funding of this project is through financial institution. The proposed Type 3 Composite LPG Cylinder manufacturing plant is envisaged to be sustainable economically, socially environmentally, and technically. The envisaged sustainability strategies of the proposed project are discussed below:

2.4.1 ENVIRONMENTAL SUSTAINABILITY

Rungas Prime Industries limited shall without prejudice comply with all statutory regulations and its own corporate guidelines on Environmental Sustainability, continuously striving for performance improvement. The proposed project is planned to operate on the use of LPG for the manufacturing process and as such will drastically reduce greenhouse gases emission.

2.4.2 TECHNOLOGICAL SUSTAINABILITY

Rungas Prime Industries Limited has engaged the services of Amtrol-Alfa, Engel, TABA which will be responsible for equipment purchase, freight, clearing, installation, plant commissioning, testing, plant and product certification. Amtrol-Alfa and MCS Consulting will assist in personnel acquisition, training and human capital development for the Project.

2.4.3 ECONOMIC SUSTAINABILITY

The Federal Government is aiming to ensure that over 4 million homes within the next two years utilize LPG, being a cleaner fuel and aims on furthering this plan via investing and facilitating local gas cylinder manufacturing. The establishment of the manufacturing plant will create other businesses that will boost the economy of the State in particular and the National in general. This business opportunities will ensure extensive economic viability and sustainability of the project. When there are business opportunities within the proposed project location, the rate of turnover for the product will rise hence improving the economic viability and sustainability.

2.4.4 SOCIAL SUSTAINABILITY

The proposed project will:

- develop and maintain effective long-term relationships with relevant stakeholders;
- create social development within the project area, social investments like building of hotels and resort centres within the host community which is conspicuously lacking as at the time of the study;
- incorporate regular consultation with all the stakeholder and host communities leading to promotion of social sustainability of the project;
- the development of social centres and resort centres will lead to social sustainability of the host communities.

2.5 PROJECT ALTERNATIVES

The assessment of impacts of the proposed project considered these main options:

- No project Option
- Project Relocation
- Project execution as proposed

During the Environmental Impact Assessment Study, the above project alternatives were reviewed in line with the project objectives in mind.

2.5.1 NO PROJECT OPTION

It is essential that the “no project option” be considered as a first step in mitigation. The “no project” option implies that the proposed project will not be carried out and the area allowed to remain in its present conditions. During the study the locations of the proposed Type 3 Composite LPG Cylinder manufacturing Plant needs this project because it is within the already acquired parcel of land by the Nigerian Content Development Management Board (NCDMB) earmarked for establishment of manufacturing facilities to boost the economy of the State and the nation in general. The Federal Government through NCDMB seeks to develop local content and this project is in line with the policy.

2.5.2 PROJECT EXECUTION AS PLANNED

Liquefied petroleum gas (LPG) cylinder is a kind of pressure vessel that requires high tensile and compressive strength to store pressurized gases. This technology aims at reduction of weight of liquid petroleum gas cylinder. The commonly used material for the manufacturing of LPG cylinder is steel. But the steel is heavier and has got some safety problems. In addition to this the steel progressively corrodes. So there arises a need to rectify these problems using some other alternatives. Significant environmental improvements will be achieved if the project is carried out as proposed due to numerous benefits accruable to the inhabitants of that area. For instance, there will be an increase in small scale business within the project area which will lead to economic and social development. Emigration will be checked; expansion of other infrastructure development will be enhanced if the project is developed as planned. The project is a development with minimal ecological and socio-economic negative impacts. Inhabitants will not move far to have the products. In line with the site verification conducted by the Representatives of Federal Ministry of Environment it was agreed that the existing project location is okay since the NCDMB has acquired and approved it as an Industrial hub to boost local content plan of the Federal Government.

2.5.3 PROJECT RELOCATION

The option of project relocation to another location is not the best option as the indigene would move far to get the product and more so, the NCDMB has approved the zone as business hub to develop the State. The establishment of the manufacturing plant will boost the sales of Liquidified petroleum gas by the Shell gas plant within the zone. In addition, there will be availability of the Type 3 Composite LPG Cylinder within the State and the host community. The employment opportunities that will arise from the project and other business opportunities that will spring up due to the establishment of the manufacturing plant will be stifled and this will lead to a continued exposure of the indigene to unemployment. There will not be economic and infrastructural development. The location of the proposed manufacturing plant is free from any infringement from the inhabitants and does not pose any significant threat to the indigene. When the indigene present at the stakeholders workshop were asked if the project should be relocated they chorused in affirmation that they even need the project earlier than now and that they will cooperate with project proponent to ensure that the establishment processes are seamless without any disturbance.

CHAPTER THREE
PROJECT DESCRIPTION

3.0 INTRODUCTION

The proposed project is a Type 3 Composite LPG Cylinder manufacturing plant with a production capacity of 400,000 units per annum. The facility will produce 80,000 units of 12kg cylinders and 320,000units of 6kg cylinders each. The technology is relatively new in the country and as such will not be obsolete soon. An LPG Composite Cylinder is superior to steel cylinder based on the following features: safety, leak detection valve, impact proof, lightweight, composite liner and does not explode in fire. The composite LPG cylinder is more durable with fifteen years requalification period as against ten years for steel gas cylinders.

The Standards Organization of Nigeria (SON) and the Department of Petroleum Resources (DPR) have recommended change from steel cylinders to composite and for cylinders to be certified periodically. Nigerian Content Development and Monitoring Board (NCDMB) has banned the importation of Steel Cylinder, effective on commencement of local manufacture of cylinders.

3.1 TYPES OF PRESSURE CYLINDERS

Pressure vessels or cylinders are basically classified into five different types depending on the materials and processes used during manufacture.

3.1.1 TYPE 1 CYLINDERS

Monolithic gas cylinders manufactured of either steel or aluminium are referred to as Type I pressure vessels. Type I vessels are predominantly either steel or aluminium and are manufactured by deep drawing and cold backward extrusion, respectively.

Monolithic cylinders are used in the containment of gases for industrial or laboratory applications. Heavy steel vessels are often used in applications where transport and maneuverability are not among the design criteria. Steel vessels are the cheapest gas storage containers in the marketplace and as such are still used. Self-contained underwater breathing apparatus systems (SCUBA) are usually produced from either steel or aluminium as the heavy vessel acts as ballast which aids buoyancy under water. In other market sectors, those in which weight is a key factor in vessel design, composites are becoming the materials of choice. The self-contained breathing apparatus market (SCBA) has moved away from aluminium cylinders. Gas cylinders such as those used by firemen and in medical applications are increasingly produced using composites. In addition to low capital costs, monolithic vessels have an unlimited life subject to periodic inspection and testing.

3.1.2 TYPE II CYLINDER

Type II cylinders or vessels are types of gas cylinders manufactured with a hoop wound composite wrap. In the type II vessels, the liners are load bearing, but a unidirectional composite wrap is laid around the circumference of the vessel. As the hoop stresses in a cylindrical pressure vessel are twice the magnitude of stresses in the axial direction, the hoop wrap is used to increase the hoop strength of the vessel. Therefore, higher charging pressures can be achieved in a type II vessel when compared to an equivalent type I vessel.

The type II liners are manufactured using either aluminium or steel. The liners are thinner than the type I cylinders and are designed to carry the axial stresses up to the design burst pressure. The composite wrap is then used to increase the hoop strength of the cylinder. Type II cylinders, as type I, have unlimited life subject to periodic testing.

3.1.3 TYPE III COMPOSITE CYLINDERS

Type III cylinders are fully wrapped composite vessels, which have a metallic liner. The liner is manufactured by cold drawing of aluminium plates. The open ends of the resulting cylinders are spun to create a closed structure. The liner is then wrapped by filament winding reinforcing tows, which are impregnated with a matrix material, around the geometry of the liner. The reinforcement material used in fully wrapped vessels is usually carbon fibre tows. Carbon fibres are used due to their high strength and low density. The matrix material is often an epoxy due to its low density, excellent adhesion properties, adequate glass transition temperature and excellent corrosion resistance.

The full wraps have reinforcement in two distinct orientations. Hoop reinforcement is wrapped around the circumference of the vessel at an angle of 85˚-89˚ from the longitudinal axis of the vessel. Two passes of hoop carbon are wound onto the vessel.

3.1.4 TYPE IV CYLINDERS

The Type IV cylinders are full wrap composite vessels with a polymeric liner. The vessel liner is manufactured using a high-density polyethylene, which is produced by reactive rotational moulding. A thermoplastic polymer is placed into a mould, which is then rotated at high speed. The polymer coats the walls of the container, which is heated to promote cure of the polymeric material. This results in a hollow container that can be wound, as would a metallic liner. Type IV vessels are mainly used for transporting and bulk storage of alternative fuels. Substantial weight savings can be gained in large vessels by using a low-density liner material. In addition to the weight saving advantages, the polymeric liners have excellent fatigue life.

3.1.5 TYPE V CYLINDERS

Type V vessels are a class of cylinders that have no distinct mandrel. The vessels can either be manufactured using washable mandrels or by winding over inflatable bladders. A second incarnation of the type V is the use of a composite mandrel that can then be filament wound. The advantages of a composite mandrel or mandrel-less design are the weight savings that can be achieved. Type V vessels are still at the development stage. Current literature about type V vessels concentrates on the effects of micro cracks on the permeability of the composite structures. The micro-cracks are caused by cyclic stresses during service or residual stresses within the composite due to manufacturing processes. Such defects are not uncommon in composite materials and usually have little effect on the mechanical properties of the composite. However, when the composite is used as a permeability barrier, as in the type V vessels, the cracks result in pathways for gas release.

3.2 RAW MATERIALS AND SOURCES

The project proponent intends to promote the Nigerian economy by facilitating training and capacity building of local indigenes of Nigeria on cylinder manufacturing. In addition, the project is being set up to ensure that all raw materials will eventually be produced within Nigeria. The goal is to have an initial mix of 80% local content and 20% international content, to gain the required cylinder manufacturing skillset. Rungas Prime will continually boost its level of local content in its project. Below is the list of raw materials for the project and where they will be purchased from.

TABLE 3.0: SOURCES OF RAW MATERIALS

S/N	RAW MATERIAL	ORIGIN/SOURCE
1	Resins	Nigeria
2	Valves	India
3	Liners	Portugal
4	Packaging	Nigeria
5	Pallets	Nigeria
6	Stretch Films	Nigeria
7	Gas	Nigeria

3.3 OVERVIEW OF COMPOSITE MATERIALS IN MANUFACTURE OF LPG CYLINDERS

Composite materials are not new and have been used for many years in the automotive, marine, and aerospace industries. More recently, composite materials have use in the manufacture a variety of cylinders and containers for transportation and storage of regulated materials. Composites are highly engineered materials designed for specific applications. They are made from two or more different materials to form one single structure with an identifiable interface. The properties of the new structure are dependent upon the overall properties of the constituent materials as well as the properties of the interface. Composite materials typically form molecular bonds in which the original materials retain their identity and mechanical properties.

Composite products are usually hybrids manufactured for specific purposes. They are made by adding some complementary material such as fiberglass to a basic carbon fiber/ epoxy matrix. The composite cylinders currently being manufactured are a polymer wrapped in fiberglass. An outer casing protects the cylinder. Construction materials include poly-acrylonitrile butadiene styrene (ABS), high-density polyethylene (HDPE), and polyethylene terephthalate (PET). The addition of carbon/epoxy to the fiberglass structure is used to provide additional stiffness. The specific materials selected for the manufacturing are designed to obtain characteristics required such as greater fracture toughness and impact resistance.

Composites have many advantages over metals, such as:

- Composites are stronger and stiffer than metals on a density basis. This characteristic is important when high performance of the material is required but weight is a factor. For example, strength being equal, composites are lighter than steel and aluminum.

- Composites are corrosion free. Most are inert even in the most corrosive environments and are leakage proof.
- Composites can be formed into complex shapes during the fabrication process and can be made from fewer parts. This reduces manufacturing and assembly time and costs.
- Ergonomically friendly, and easy handling
- Composites can be made so they are translucent, which allows the user to view the level of product inside, or they can be blended with colours.
- Reduced maintenance cost.
- Reduced risk of static build-up and are explosion proofed.
- Increased vaporization capacity and offers high safety and reliability
- Composite materials can be made translucent so that the content inside can be easily and safely viewed.

3.3.1 TYPE 3 COMPOSITE LPG CYLINDER

The Type 3 composite LPG cylinders currently being manufactured are a polymer wrapped in fiberglass with an outer casing protecting the cylinder. Construction materials include poly-acrylonitrile butadiene styrene (ABS), high-density polyethylene (HDPE), and polyethylene terephthalate (PET). The addition of carbon/epoxy to the fiberglass structure is used to provide additional stiffness. The proposed Type 3 Composite LPG cylinders has some features like the shock absorber, steel liners, composite layer, and polymeric jacket. Composites are a combination of two or more different components to form a material with the desired properties of each. This premise has led to a vast amount of development in the field of polymer matrix composites, which promise lightweight, high stiffness, high strength structures. The high specific properties of the materials come at a cost. The manufacturing routes of such materials can be time and labour intensive. As a result, the costs of composite components are high in comparison to equivalent metallic components. Composite gas cylinder development and manufacture has been driven by the needs of the end user. Innovations over the past 35years have resulted in lighter vessels capable of higher charging capacities due to the low density, high strength materials available and advances in their manufacturing processes.

FIG 3.0: STRUCTURE OF THE TYPE 3 COMPOSITE CYLINDER

3.3.2 SAFETY & LAYER OF PROTECTION(LOPA) FOR TYPE 3 COMPOSITE LPG CYLINDERS

The proposed type 3 composite LPG cylinder manufacturing technology has considered some level of safety and layers of protection. There are basically four levels of protection.

- **Shock Absorbers**
  Shock absorbers located on the top and the bottom of the cylinders, help dissipate the energy from physical shocks.
- **Steel Liner:** The coat-protected high strength steel metallic liner provides optimal safety.
- **Composite Layer:** Between the liner and the cover rests a composite fiber, increasing lightness and resistance to shock through its malleability.
- **Polymeric Jacket:** The body is resistant to ultraviolet (UV) radiation and features shrouds that are both ergonomic and stackable.

3.3.3 TYPE 3 COMPOSITE LIQUEFIED PETROLEUM GAS (LPG) CYLINDER TECHNOLOGY

In aerospace applications, weight reduction of a component is of prime requirement, whereas in commercial household applications, reliability/safety as well as weight of the component is given more importance. Keeping the issue of reliability and weight in view, the high-end composite material technology can very well be implemented in design of household LPG cylinders. Any pressure vessel made of metallic materials has a major drawback of severe bursts in worst cases. For example, when gas cylinders catch fire, it explodes heavily creating danger for its users. Whereas composite gas cylinders don't explode (Leak before fail approach) due to porosity formation of materials. Due to formation of leakage through the thickness, the flames simply start coming out slowly, which is a fail-safe design approach.

The technology of LPG cylinders has gone green which is a sharp turn away from the era of steel cylinders with heavy weight and ability to corrode easily. The new technology of Type 3 composite LPG cylinders is eco-friendly and LPG gases are contained in low pressure cylinders. Traditionally these were of a steel construction, but in today's market composites and plastics are increasingly being used. To ensure that these low-pressure Type 3 cylinders are fully recyclable, there is the avoidance of the use of thermosetting resins. Instead, by opting for polypropylene to bind the fibres. It can be melted and reused just like the other plastics.

3.3.4 THE NATURE OF LIQUEFIED PETROLEUM GAS(LPG)

The Liquefied Petroleum Gas (LPG) is a colourless liquid which readily evaporates into a gas, comprising mainly propane (C_3H_8), propylene(C_3H_6), butane(C_4H_{10}) and butylene (C_4H_8) with vapor pressure not exceeding 16.87kg/cm2 (gauge) at 65^oC. Domestic cooking gas has a remarkably high energy content (calorific value=46.1 MJ/KG). It is used as a fuel in heating appliances and vehicles. It is now increasingly used as an aerosol propellant and a refrigerant, replacing chlorofluorocarbons to reduce damage to the ozone layer. LPG is stored and handled as a liquid when under pressure inside an LPG gas container. When compressed moderately at normal temperature, it becomes liquid. When gas is withdrawn, the pressure drops, and the liquid reverts to gas. This means that it can be transported and stored as liquid and burnt as gas. LPG is odourless but a stench agent is added to assist in its detection in case of leakage. The odourant used in LPG is ethyl mercaptan, which owns a distinctive and unpleasant odour. Ethyl mercaptan is selected because it is non-corrosive, has low sulphur content and possesses a boiling point near that of LPG.

LPG is a low carbon emitting hydrocarbon fuel, emitting 19% less CO_2 per kWh than oil and 30% less than coal. The gas can be liquefied at moderate pressure and can be stored in cylinders as a liquid under pressure and is drawn out and used as gas. This means that it can be transported and stored as liquid and burnt as gas. The expansion ratio of gas from liquid is 270:1 at atmospheric pressure. It is this expansion factor which makes LPG more economical to transport and store large quantities of gaseous fuel in a small container in liquid state. LPG inside a container is in two states of matter, liquid and vapour. The liquid portion of container is in the bottom and the vapour is in the uppermost part of the cylinder. Cylinders are normally filled 80-85% liquid, leaving a 15-20% vapour space for expansion due to temperature increase.

3.4 PROCESS DESCRIPTION

There are three major cylinder characteristics that impact design and component selection, viz, durability, cost and weight. These features are incorporated during the design, manufacture of the composite LPG cylinders. In the manufacturing process of type 3 composite LPG cylinders the basic components and processes which are HDPE Liner (Blow molding); LPG pressure valve, fibre reinforcement (filament winding) and the housing (Injection molding process).

3.4.1 MANUFACTURING PROCESS

There are a select number of manufacturing processes used to produce gas cylinders. The specific manufacturing process employed in the manufacture of a cylinder is dependent on the type of material used to manufacture the cylinder. Pressure vessels are classified into Types I-V. The classifications given to specific cylinders are dependent on the materials used in the manufacturing process. Currently, cylinder types I-IV are commercially produced and operated by end users. These vessels are employed in different market sectors according to the requirements of the given application.

Steel and aluminium were the first materials to be used in the manufacture of gas containment cylinders. Steel vessels, manufactured by deep drawing, are relatively easy to produce but are heavy. Aluminium is a lighter alternative to steel, with the added benefit of corrosion resistance. Such vessels are produced using the cold backward extrusion method, during which an aluminium billet is deformed using a hydraulic ram. Composite cylinders are now becoming more prevalent in the market. Lighter vessels can be produced using low-density carbon fibre composites. Higher charge pressures are also possible due to the high strength of the carbon composites. The basic manufacturing processes of type 3 composite cylinders is outlined below.

3.4.1.1 LINER MANUFACTURE

Type III cylinder liners are manufactured by deep drawing cylindrical shells from circular plates of HDPE. The plates are placed over a forming die that is of larger diameter than the desired vessel. A cylindrical ram then forces the HDPE into the die forming a canister that is closed at one end. The process is repeated using smaller die sizes until the correct diameter is achieved. The open end of the cylinder is then closed into a dome using metal spinning techniques. A tool is used to form the contour of the neck while the liner spins at high speed.

3.4.1.2 FILAMENT WINDING EQUIPMENT

Traditional filament winding equipment consists of three main parts, the creel, the impregnator, and the wind head. A schematic layup of the filament winding equipment is shown below. The supply of reinforcement is provided from multiple packages. The packages are held on a tension-controlled creel. The tows pass from the creel to the resin impregnator then on to the wind head.

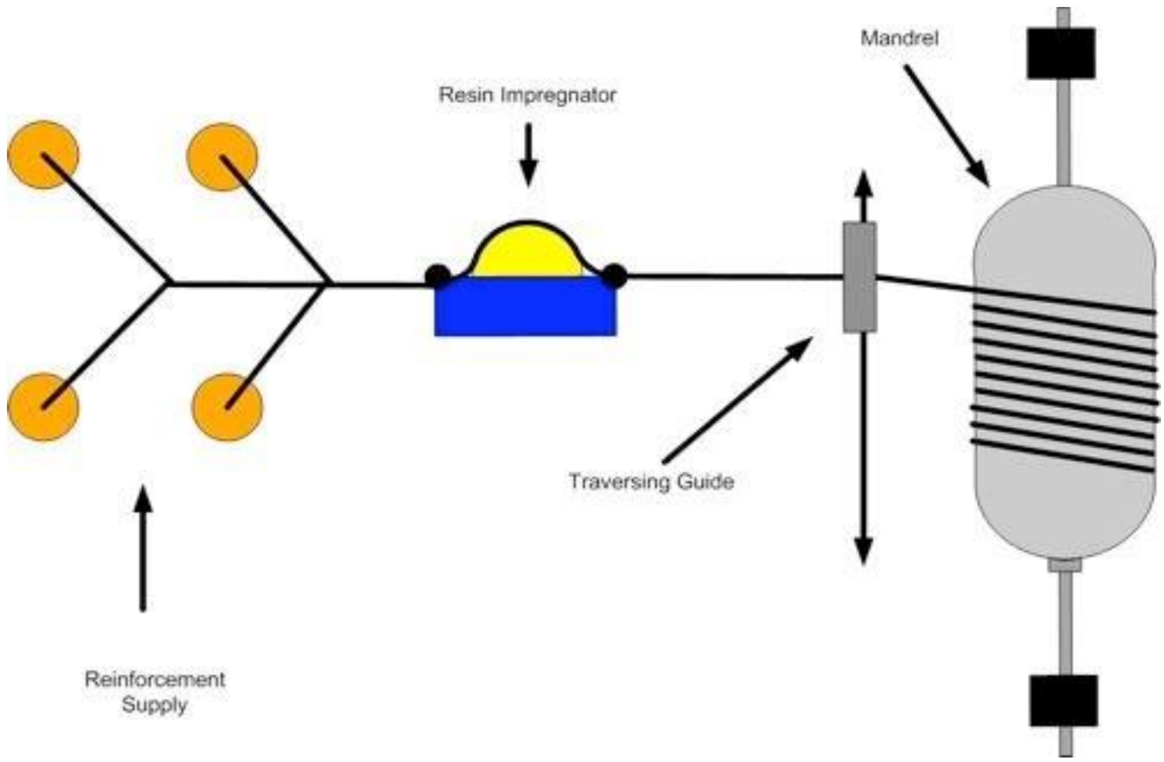

FIG. 3.1 : DIAGRAM OF FILAMENT WINDING SET UP FOR CYLINDER PRODUCTION

CREEL

Reinforcement tows are held on packages that are mounted onto the creel below. The creel applies a running tension to the reinforcement tow.

FIG 3.2: A TYPICAL CREEL USED IN FILAMENT WINDING

TOW IMPREGNATOR

In wet winding, the tows pass through an impregnator to infuse the fibres with liquid resin. The impregnation occurs on-line as the tows are taken from the creel to the wind head. The impregnator consists of a resin bath, where premixed resin is held. A rotating drum, a doctor blade and sets of tow guides. The reinforcement tows enter the impregnator and pass around a fixed guide. The tows are spread by the guide and move on to contact the rotating drum. The resin is carried from the bath to the point of contact between the drum and fibres. A doctor blade controls the amount of resin at the contact point. The gap between the blade and the drum can be varied as necessary to increase and decrease the amount of resin entering the tow. Excess resin is scraped from the surface of the drum and falls back into the resin bath.

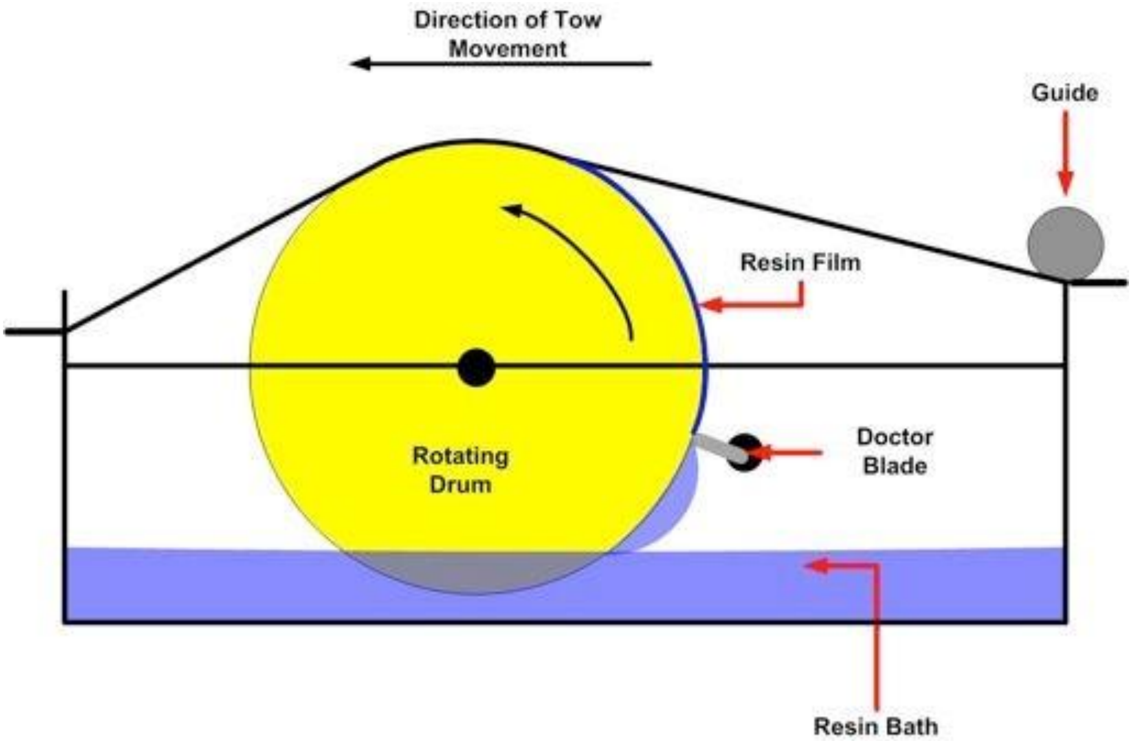

FIG 3.3: DIAGRAM SHOWING THE TOW IMPREGNATOR

Wind Head

The vessel liners are wrapped at a winding station in the filament winding process. Each machine can carry up to 5 mandrels, which are wrapped simultaneously. As the diameter of the vessel increases, fewer spindles can be used thus the quantity of the filament winding process reduces as the larger vessel sizes are wrapped. This results in reduced amount for larger sized vessels, leading to increased costs for vessels of increasing diameter. Tows are laid on the surface of the mandrel as a band. Several tows are combined to form a tape at the wind head spreading guides. The bandwidth is decided during the design stages and is largely dependent on the size of the mandrel and the wind angles required. A large bandwidth is desirable to minimize the manufacturing time, however poorly designed bandwidths can result in overlapping of the tows in the helical layers, causing resin rich regions or fibre deviations in the structure. This occurs in bandwidths that are too large. Bandwidths that are too small cause gaps between the helical pass, resulting in voids in the structure.

PLATE 3.0: WIND HEAD - WET PROCESS

3.4.1.3 WINDING CONFIGURATIONS

Composite structures of varying laminate configurations can be produced easily by changing the parameters of the filament winding process. The orientation of the yarns is dependent on two machine variables: the rotational speed of the mandrel and the traverse speed of the reinforcement guide eye. There are two main winding configurations available to the operator. In hoop winding the reinforcement is wrapped around the circumference of the mandrel. The wind eye travels along the length of the mandrel slowly while the mandrel rotates at a high speed. Helical winding is used to wind reinforcement at lower angles. For more complex paths, such a geodesic, multi-axis Computer Numerical control (CNC) machinery is required to place the tow on the correct path by synchronizing mandrel rotations and guide manipulations. For low angle reinforcement the mandrel is rotated slowly, and the wind eye is traversed at high speed.

An important part of any composite manufacturing process is compaction of the material. A compacted part is less likely to contain voids and resin rich regions, which can have detrimental effects on the composite. In the manufacture of aerospace grade composite, pressurized autoclaves are used to generate the consolidation pressure. In liquid resin processes, a vacuum or mechanical clamping pressures generate the compaction forces. In filament winding, the consolidation is carried out by the tows themselves as subsequent wound layers compress the previous layers. The magnitude of this compressive force is dependent on the winding tension of the reinforcement band.

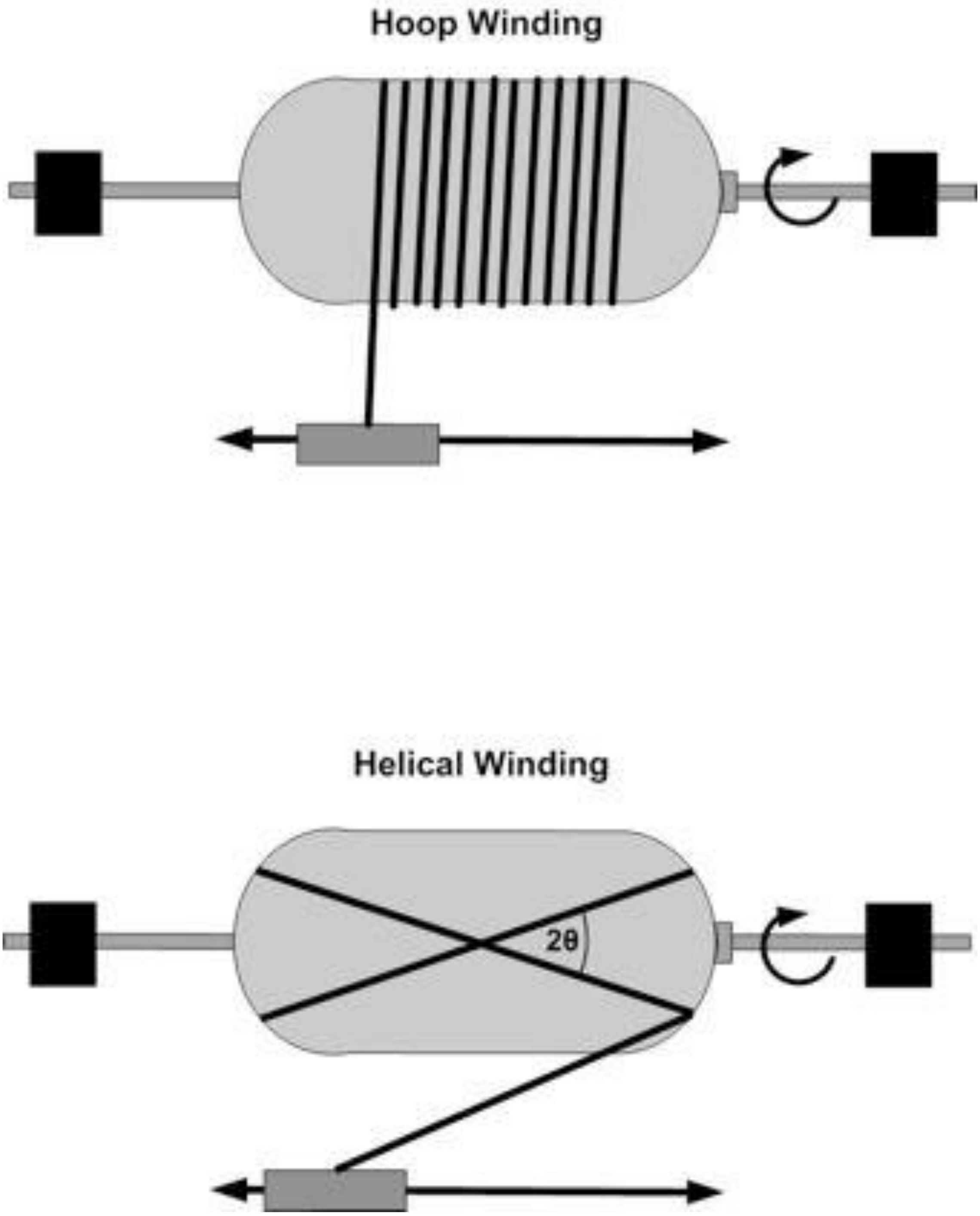

FIG 3.4: HOOP AND HELICAL WINDING CONFIGURATIONS

3.4.1.4 PRE-IMPREGNATED TOW WINDING

Pre-impregnated tows, or tow-preg, can also be used in filament winding. The tows contain a partially cured resin system in addition to the fibre reinforcement. In tow-preg winding there is no longer a need for the resin impregnation stage. This has several benefits. Firstly, the tow preg is a much cleaner method of manufacture as liquid resin tends to drip and coat machinery. Secondly, any resin wastage due to exceeding pot life is eliminated. High winding tensions are required during tow preg winding. The high tow tensions ensure that the composite is well consolidated and that inter-tow voids are eliminated. In the wet process, the liquid resin is of a low enough viscosity to fill any macro porosity ensuring that the load can be transferred between lamina and between tows effectively. Resin movement during processing of pre-impregnated composite is limited in comparison

3.4.2 MANUFACTURING PROCESS FLOWCHART

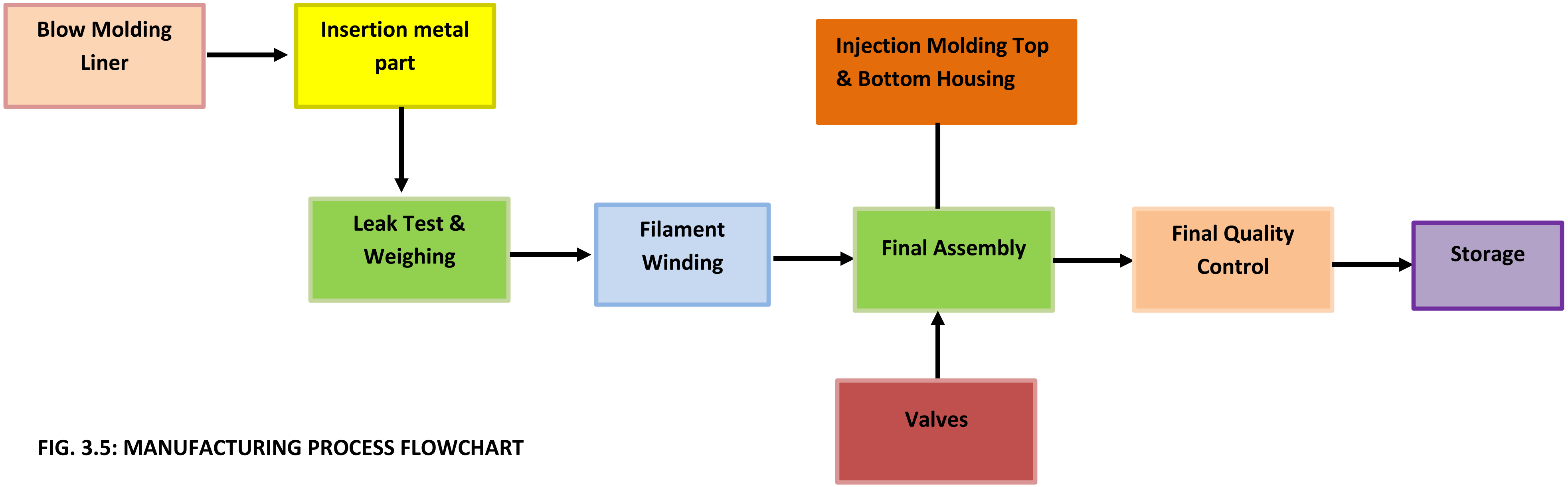

FIG. 3.5: MANUFACTURING PROCESS FLOWCHART

CHAPTER FOUR

4. DESCRIPTION OF PROJECT EXISTING ENVIRONMENT

4.0.1 GEOGRAPHICAL LOCATION OF STUDY AREA:

The project is located within Polaku community in Yenagoa Local Government Area of Bayelsa State within the Niger Delta Region. Just like Bayelsa State, the proposed project area is a lowland characterized by tidal flats and coastal beaches, beach ridge barriers and flood plains. The net features such as cliffs and lagoons are the dominant relief features of the state. The fact that the state lies between the upper and lower Delta plain of the Niger Delta suggests a low-lying relief. The broad plain is gentle sloping. The height or elevation decreases downstream.

FIG. 4.0: MAP OF NIGERIA SHOWING THE STATE WHERE THE PROJECT IS LOCATED

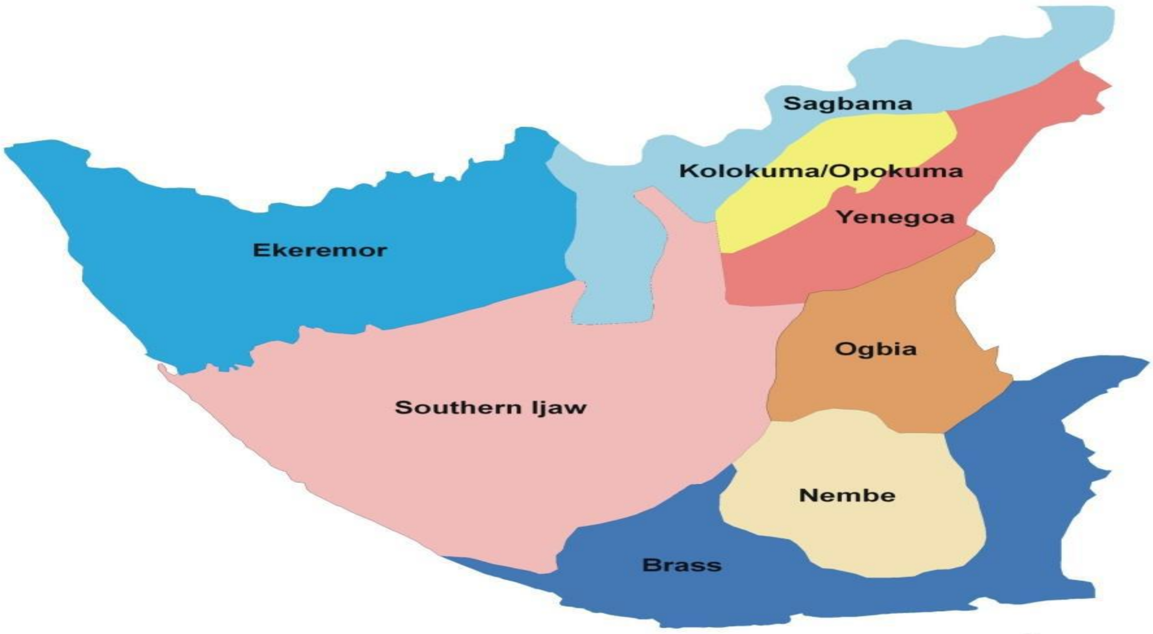

FIG. 4.0.1: YENAGOA LOCAL GOVT AREA OF PROJECT LOCATION

FIG. 4.0.2: PROPOSED PROJECT LOCATION

4.0.2 GEOGRAPHICAL POSITIONING SYSTEM (GPS) COORDINATES FOR THE PROJECT SITE.

The proposed project site (2Ha of land) is located within the existing NCDMB 11Ha of land with GPS coordinates as stated below.

TABLE 4.0: GPS COORDINATES OF THE PROJECT SITE

Boundary	DD Latitude:	DD Longitude:	UTM E: (m.)	UTM N: (m.)
Rungas gate 1	5.031936	6.289816	199544.567	556697.175
Rungas gate 2	5.032019	6.28995	199559.476	556706.277
Boundary B	5.030513	6.291359	199715.149	556539.074
Boundary C	5.028726	6.289157	199469.956	556342.282
Boundary D	5.029415	6.286173	199139.113	556419.862
Boundary E	5.030311	6.286357	199159.944	556519.021
Boundary F	5.030896	6.288158	199360.077	556582.849
Boundary G	5.030908	6.288388	199385.567	556584.125
Boundary H	5.030956	6.288626	199412.025	556589.281
Boundary I	5.03105	6.288814	199432.919	556599.625
Boundary J	5.031176	6.289136	199468.71	556613.436
Boundary K	5.03147	6.289117	199466.703	556645.965

4.0.3 METEOROLOGY AND CLIMATE:

The meteorology of Nigeria is briefly classified under South and North zone. Distinctly two season's annually wet season and dry season in project influence within the State and Nigeria in general. The project falls under south-West zone hence long dry season persist a long time from October to April while rest of months of a year included under wet seasons. Generally, the dry season starts with Harmattan-a dry chilly spell that lasts until February and a dusty atmosphere is brought about by the northeast winds blowing from the Arabian Peninsula across the hot Sahara Desert. Generally, temperatures are high throughout the year because Nigeria lies within the tropics and the mean monthly figure could go above 28.4 ^{0}C, while daily maximum temperatures can go beyond 32.8 ^{0}C.

4.0.4 RAINFALL

Rainfall in Bayelsa State varies in quantity from one area to another. Just like Bayelsa State, the project area experiences equatorial type of climate. Rain occurs generally every month of the year with heavy downpour. Rainfall varies from place to place and from season to season. In the wet season, the full effect of the tropical maritime air mass is the main reason that brings rainfall, while in the dry season the rainfall is less. The total annual rainfall decreases from the south to the north. Rain falls throughout the year in Yenagoa and the most rain falls around April to September 4, with an average total accumulation of 15.0 inches.

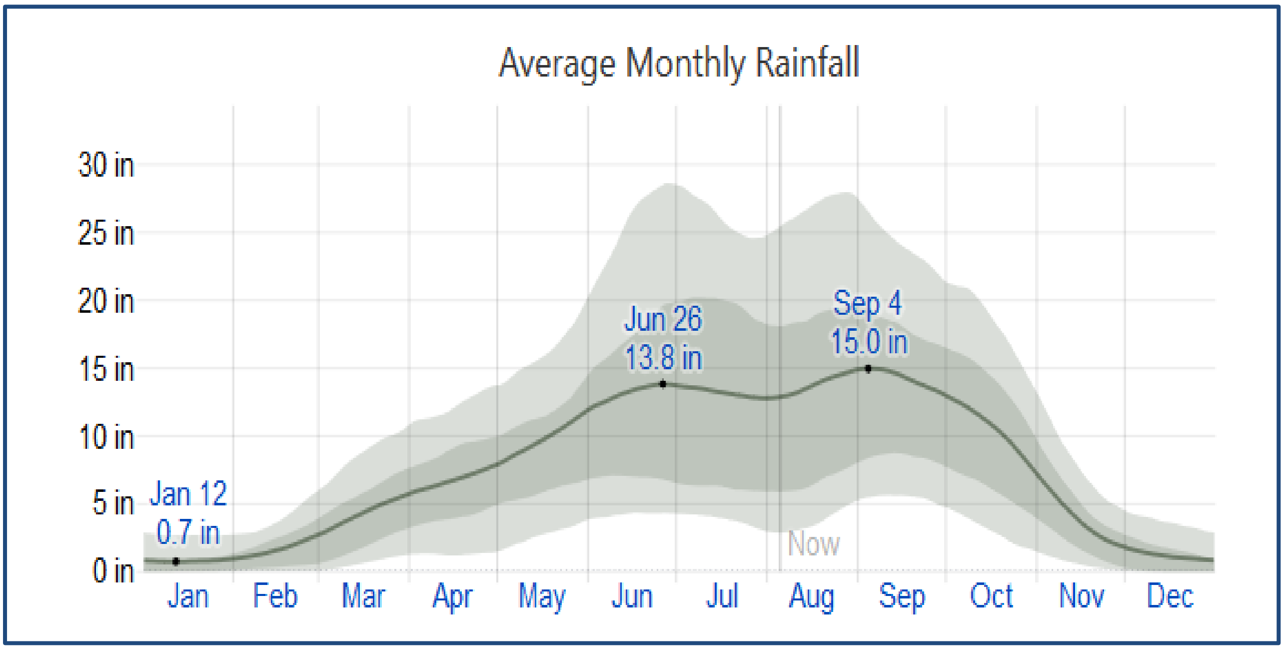

FIG 4.1 MEAN ANNUAL RAINFALL **Source: NIMET/weatherspark**

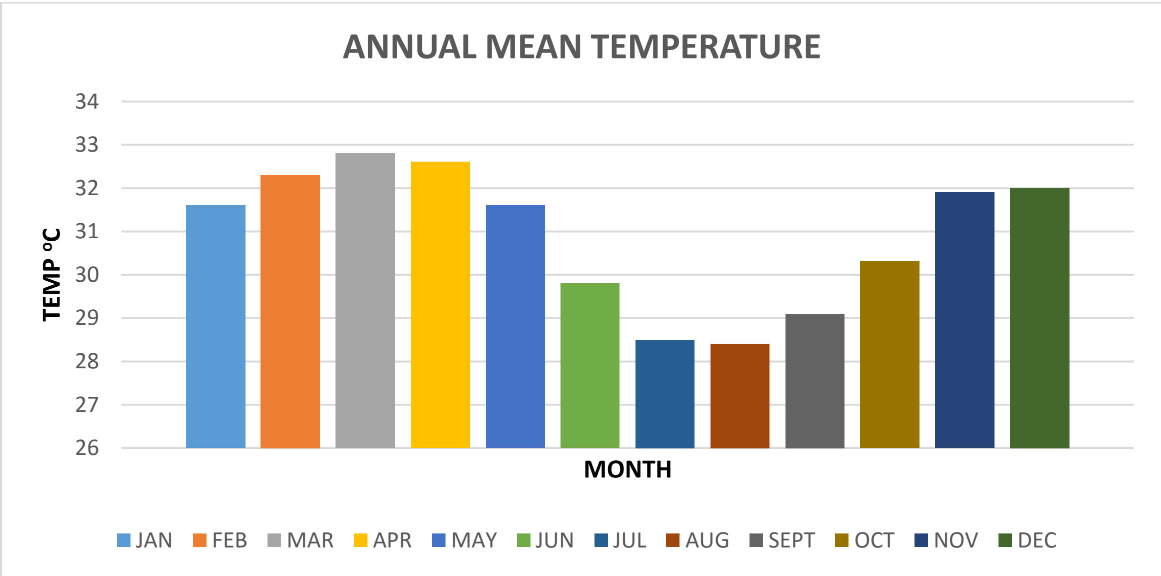

FIG. 4.2: ANNUAL MEAN TEMPERATURE DISTRIBUTION IN PROJECT AREA. (SOURCE: NIMET)

4.1 TEMPERATURE, CLOUD COVER AND PRECIPITATION

The mean monthly temperature is in the range of 25°C to 31°C. Mean maximum monthly temperatures range from 26°C to 31°C. The mean annual temperature is uniform for the entire Bayelsa State. The hottest months are December to April. The difference between the wet season and dry season on temperatures is about 2°C at the most. Relative humidity is high in the state throughout the year and decreases slightly in the dry season.

The mean daily maximum (solid red line) shows the maximum temperature of an average day for every month for Yenagoa. Likewise, mean daily minimum (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years. From the above the data indicates that lower temperatures were recorded during the wet season, between May to October, while higher temperature were recorded in the dry season from October to April. It is obvious that the rains appear to have a moderating influence on temperatures in Nigeria which imparts a demarcation in microclimatology of north and south Nigeria.

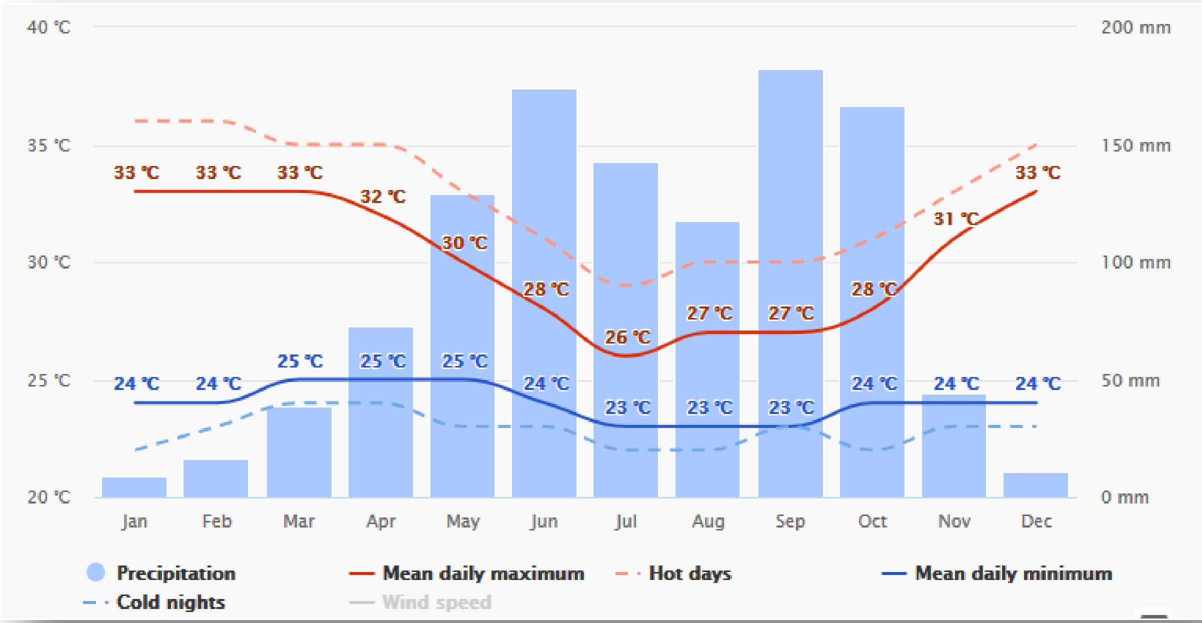

FIG. 4.3:TEMPERATURE, CLOUD COVER AND PRECIPITATION OF THE PROJECT AREA. (SOURCE:

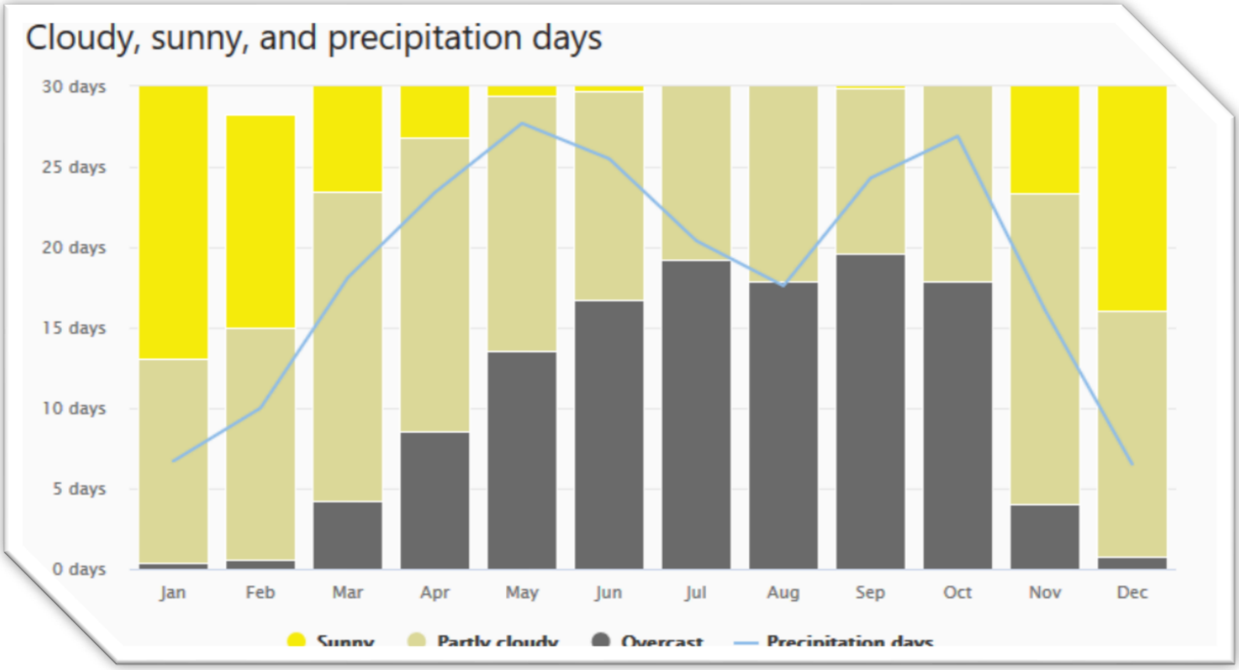

FIG 4.4: CLOUDINESS, SUNSHINE & PRECIPITATION OF THE PROJECT LOCATION

4.2 RELATIVE HUMIDITY

Relative humidity (RH) is the ratio of the partial pressure of water vapour to the equilibrium vapour pressure of water at a given temperature. Relative humidity depends on temperature and the pressure of the system of interest. It requires less water vapour to attain high relative humidity at low temperatures; more water vapour is required to attain high relative humidity in warm or hot air. Relative humidity is normally expressed as a percentage; a higher percentage means that the air–water mixture is more humid. Poor indoor air quality (IAQ) is caused by several factors and can cause a variety of general symptoms, including headaches, eye irritation, sinus pain, and fatigue. Poor IAQ can also exacerbate existing respiratory illness or intensify eye, ear, nose and throat, conditions. Inappropriate air temperature or humidity levels can cause sinus problems and general discomfort.

Generally, in Nigeria, July is the middle of the wet season and the relative humidity is high because of the warm wet air that prevails. The humidity is over 80% in the South and never goes below 60% in the north. Over 80% of the rains fall within the wet months of April-September. In the South, the figure is above 70% and, in the north, nearly 100% of the rains are during these months. The relative humidity for last decade of project site suggest that the lowest mean value is 71.7 % in January while the mean peak value rises to 85.9% in July. The details about mean relative humidity for last ten years (2005-2015) have been shown here in **Figure 4.5.**

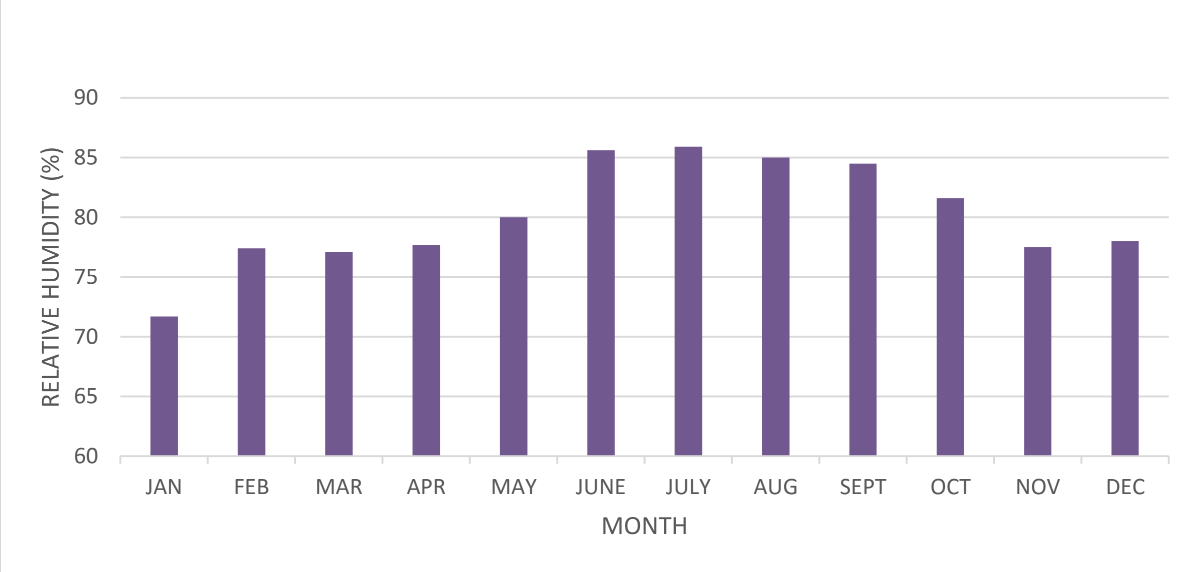

FIG. 4.5: RELATIVE HUMIDITY DISTRIBUTION IN PROJECT AREA. (SOURCE: NIMET)

4.2.1 AMBIENT TEMPERATURE AND RELATIVE HUMIDITY OF THE STUDY AREA

The ambient temperature and relative humidity of the project location were measured using the Smart Sensor (Model: AR830) which can measure Relative Humidity, Temperature and Particulate Matter. See below table for the readings.

TABLE 4.1: AMBIENT TEMPERATURE & RELATIVE HUMIDITY OF THE STUDY AREA

S/N	Sampling Points	Coordinates		Elevation (m)	Ambient Air Temp.°C	Relative Humidity (%)
		E	N			
1	AQ1	199474.584	556826.083	8.69	33.1	50.4
2	AQ2	199532.187	556768.069	8.39	33.1	47.7
3	AQ3	199567.810	556699.918	10.08	32.3	47.1
4	AQ4	199578.590	556651.363	9.75	33.0	53.9
5	AQ5	199474.169	556625.071	8.75	31.5	52.7
6	AQ6	199438.014	556533.202	8.37	32.3	61.3
7	AQ7	199347.733	556479.258	7.31	30.3	60.4
8	AQ8	199280.590	556633.052	9.25	30.1	65.2

S/N	Sampling Points	Coordinates		Elevation (m)	Ambient Air Temp.°C	Relative Humidity (%)
		E	N			
9	AQC1	199483.204	556844.326	8.76	30.0	65.6

The ambient temperature and relative humidity of the project location were measured with the reports presented graphically below.

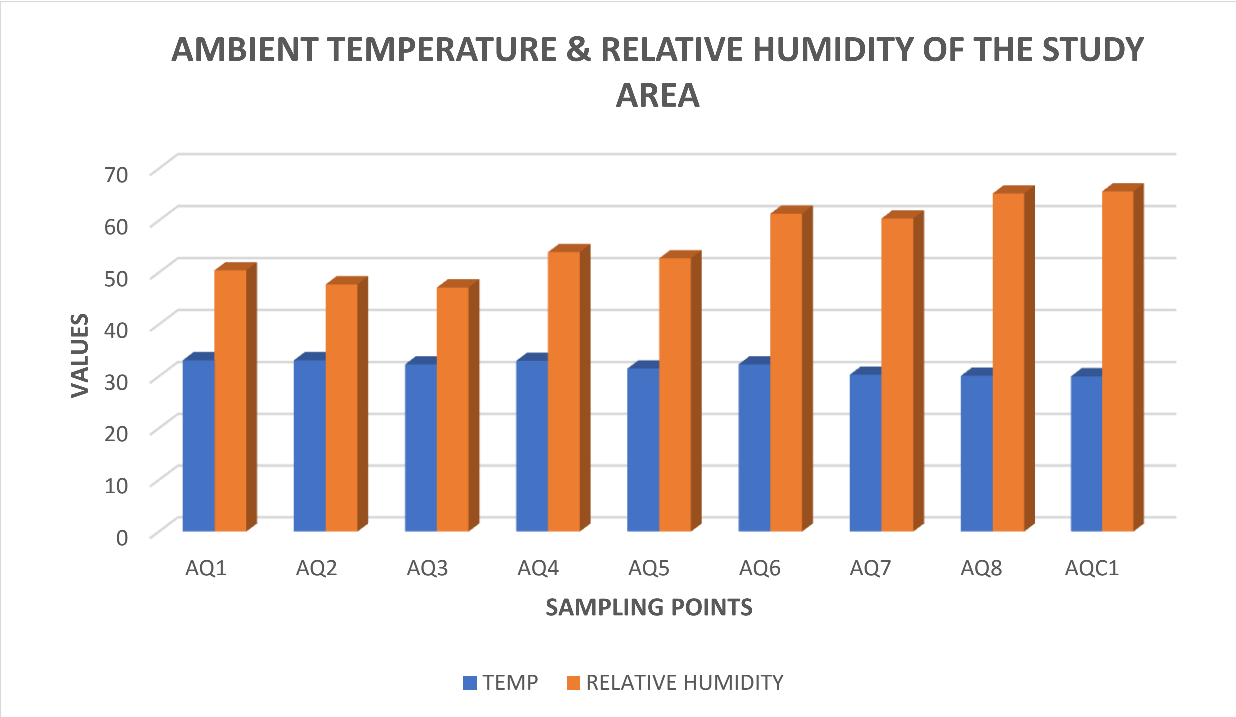

FIG 4.6: AMBIENT TEMPERATURE & RELATIVE HUMIDITY WITHIN THE STUDY AREA

Source : Field work

4.3 WIND SPEED AND DIRECTION

The average annual speed in the project area as it is related to Yenagoa ranges from 1.2m/s in April and 2.3m/s in November. The measured average wind speed within the project site was 1.3m/s. The wind rose for Yenagoa shows how many hours per year the wind blows from the indicated direction (SW: Wind is blowing from South-West and (SW) to North-East (NE).

TABLE 4.2: MONTHLY WIND SPEED IN YENAGOA

Month/year	2013	2914	2015	2016	2017	Mean wind speed (m/s)
January	1.608	3.138	1.215	2.375	1.271	1.9
February	3.156	3.306	3.392	0.786	1.044	2.3
March	1.344	3.113	1.665	0.993	1.641	1.8
April	2.324	3.361	2.248	1.010	1.014	2.0
May	3.321	1.818	1.727	0.770	0.579	1.6
June	1.723	2.332	1.018	1.145	1.277	1.5
July	1.325	1.783	0.614	1.062	1.233	1.2
August	1.480	2.011	0.623	1.085	1.416	1.3
September	0.701	2.345	1.415	1.286	1.422	1.4
October	1.400	2.666	1.289	1.371	1.688	1.7
November	1.823	2.340	1.314	1.376	2.168	1.8
December	1.942	2.566	1.456	1.571	2.675	2.0

SOURCE: **NIMET**

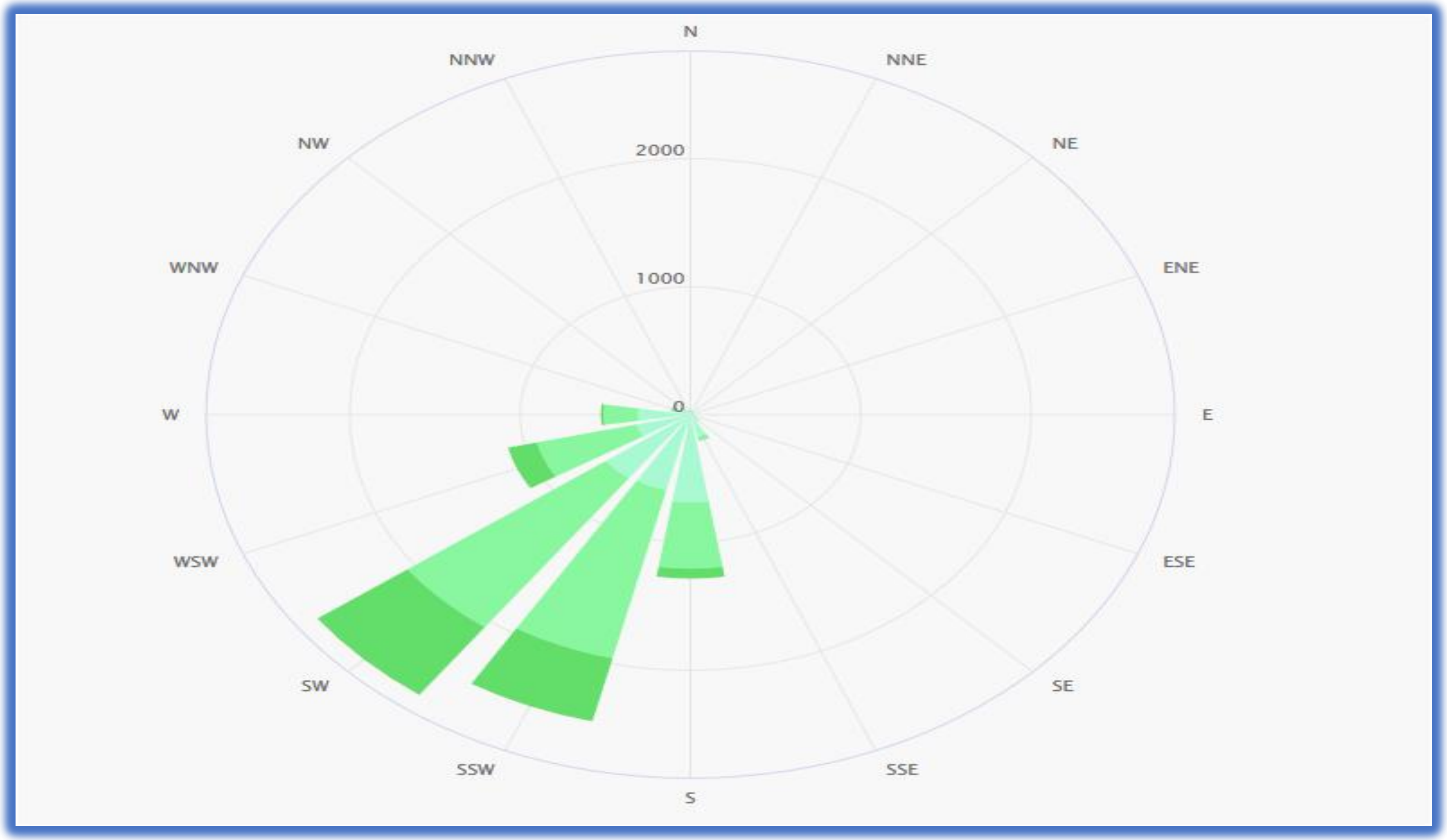

FIG 4.7.: WIND ROSE OF THE STUDY AREA

4.4 PHYSIOGRAPHY AND GEOLOGY

Physiography and Geology of Kolapu, Yenagoa Local Government Area

The proposed project is located approximately within Yenagoa Local Government area of Bayelsa State. The vegetation of the state is transitional between the Guinea and Sudan Savanna. There are two distinct seasons, the rainy season extends from April to October and the dry season is between November and April. The mean annual temperature ranges between 23.0^{0}C to 33.0^{0}C. The annual rainfall within 15inches. The project is within Yenagoa in Bayelsa State and it is located within the lower Delta plain believed to have been formed during the Holocene of the quaternary period by the accumulation of sedimentary deposits. The major geological characteristic of the state is sedimentary alluvium. The entire state is formed of abandoned beach ridges and due to many tributaries of the River Niger, Nun River & Taylor creek in this plain, considerable geological changes still abound.

4.5 BASE LINE DATA ACQUISITION METHODOLOGY AND STUDY APPROACH

ACQUISITION OF BASELINE DATA

The purpose of the baseline data acquisition is to establish the status of the various environmental components before the execution of the project. To achieve this, the environmental parameters were acquired from literature survey. The components of the environment covered are biophysical, social, and health.

The broad objectives of this process included:

- Education and enlightenment of identified stakeholders (communities, Government agencies, non-governmental organizations (NGOs), community based organisations (CBOs) on the need for their involvement in the conduct of the study and to assist the project team in articulating the concerns of the communities as well as those of their immediate environment.
- Building trust and confidence that would enhance the capacities of the identified stakeholders through participation in the project and
- Forming and promoting partnership with identified stakeholders through networking, information sharing and participation in consultation exercises.

4.6 QUALITY ASSURANCE/QUALITY CONTROL (QAQC)

The quality control & quality assurance (QA/QC) of all samples and the whole process is a vital aspect of this project and the conduct of the Environmental & Social Impact study. This starts from field works, collection of samples, analysis, and documentations. Standard methods and procedures have been strictly adhered to during this study. QA/QC procedures were implemented during sample collection, labelling, analyses, and data verification. Chain of custody procedures including sample handling, transportation, logging, and cross-checking in the laboratory have also been implemented. All analyses were carried out in FMENV accredited laboratories. The methods of analyses used in this study were in compliance with nationally and other internationally accepted analytical procedures, in order to ensure the reliability and integrity of the data obtained.

4.7 SAMPLING STRATEGY

The sampling strategy is an essential component of quality assurance and quality control. The sampling and data collection for the environmental components and parameters were in accordance with recommended procedures and practices for environmental data collection in Nigeria (FMENV 1992 and DPR, 2002 Part vii D – sampling and handling of samples). This is done to ensure that the nature, characteristics of the samples is not altered in any way. Samples were collected and stored in coolers to maintain their characteristics and compositions.

4.8 AIR QUALITY AND NOISE STUDIES

The rate of air pollution is becoming worrisome and therefore needs an urgent redress. It is becoming a major factor in the quality of life of urban and rural dwellers, and it poses risk to both human health and the environment. Therefore, it is necessary to study the background quality of the air prior to any project and to predict the impact(s) such a project would have on the air quality. Thus, the following air quality parameters were sampled during the field work viz: Particulate Matter (PM), Sulphur IV Oxides (SO_2), Nitrogen IV Oxide (NO_2), Carbon Monoxide (CO), Hydrogen Sulphide (H_2S), Volatile Organic Compounds (VOCs), ammonia (NH_3) and Hydrocarbon gases using highly sensitive digital in-situ Gas Monitors. The background noise levels were measured using a portable digital sound level meter.

4.8.1 AIR QUALITY MEASUREMENT

In the process of previewing the environmental performance of a proposed project, the ambient air condition is studied, to monitor air pollutant concentrations. During this study, key pollution indices (air pollutants) like PM ($\mu g/m^3$), CO ($\mu g/m^3$), SO_2 ($\mu g/m^3$), NO_2 ($\mu g/m^3$), H_2S ($\mu g/m^3$), and NH_3 ($\mu g/m^3$) were measured at designated transects, using portable gas meters. In the present project, as part of knowing the air quality parameters, the above parameters were monitored and are monitored at designated locations as given below.

TABLE 4.3: **GPS COORDINATES OF AIR QUALITY MONITORING**

S/N	AIR QUALITY SAMPLING POINTS	COORDINATES (32N)		ELEVATION
		E	N	
1	AQ1	199474.584	556826.083	8.69m
2	AQ2	199532.187	556768.069	8.39m
3	AQ3	199567.810	556699.918	10.08m
4	AQ4	199578.590	556651.363	9.75m
5	AQ5	199474.169	556625.071	8.75m
6	AQ6	199438.014	556533.202	8.37m
7	AQ7	199347.733	556479.258	7.31m
8	AQ8	199280.590	556633.052	9.21m
9	AQC1	200315.547	556964.632	9.49m

WHERE AQ= Air Quality & AQC= Air Quality Control
Source: Field work

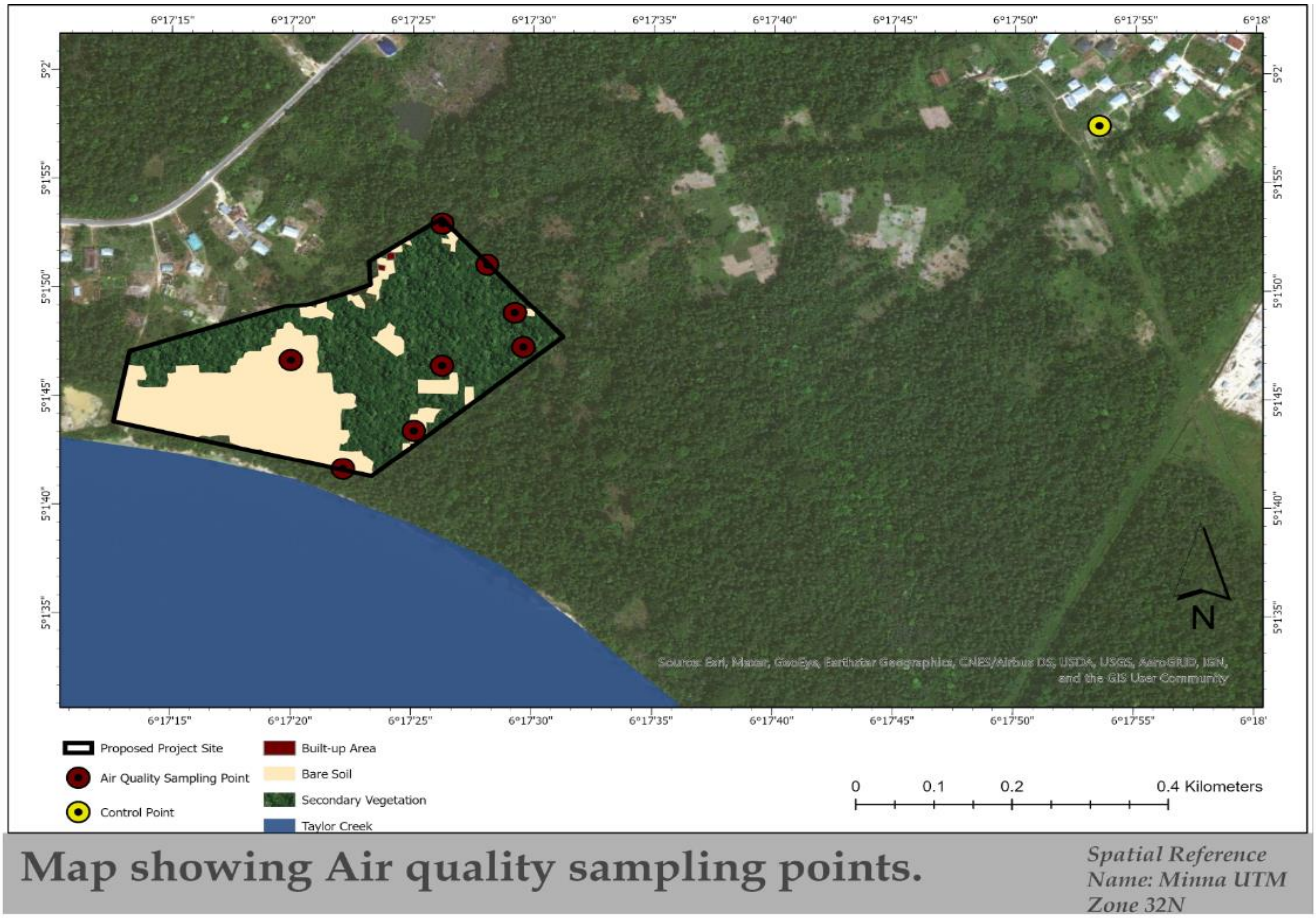

FIG. 4.8:MAP SHOWING AIR QUALITY SAMPLING POINTS

PLATE 4.0:MULTI GAS QUALITY MONITORS

PLATE 4.1 A: EIA CONSULTANT CONDUCTING AIR QUALITY MONITORING AT THE PROPOSED SITE

PLATE 4.1 B: SOME AIR QUALITY MONITORING KITS

The details of the air quality results are given below. It has been observed that overall, all the parameters are well within the permissible limits.

4.8.2 NOISE QUALITY

The noise levels were measures in nine (9) locations in an around the project area in line with Federal Ministry of Environment's approved terms of reference. For getting a quality result, well planned monitoring location has been selected. The details of noise quality assessment are given in **Tables 4.1- 4.1.2.**

PLATE 4.2: EIA CONSULTANT CONDUCTING NOISE MONITORING

TABLE 4.4: AIR POLLUTANTS & EFFECTS

POLLUTANTS	POSSIBLE EFFECTS (HEALTH)	ENVIRONMENTAL EFFECTS
Sulphur (IV) Oxide (SO_2)	Worsening respiratory illness from short-term exposure; increased respiratory symptoms including chronic bronchitis from long-term exposures.	Acidification of soils, lakes & rivers, damages to plants & crops; corrosion of buildings, monuments & works of art.
Suspended Particulate Matter	As for SO_2; combined exposure to SO_2 & SPM are associated with pulmonary effects; are carcinogenic elderly & the young are particularly susceptible.	Stain fabrics, painted surfaces & buildings, reduces life of materials and surface finishes.
Nitrogen (II) Oxide (NO_2, N_2O and NO)	NO_2 affects lung function in asthmatics from short-term exposures; causes chest tightness, burning of the eyes & headaches.	N_2O can absorb infrared radiation & may enhance global warming & destruction of Earth & Ozone layer
CO	Reduced Oxygen-carrying capacity	CO has no known effects on

	of blood by formation of Carboxyhaemoglobin instead of oxyhaemoglobin formation	vegetation or materials.
Hydrocarbons C_xH_y		Greenhouse gases that trap heat leading to global warming

SOURCE : URBAN AIR POLLUTION, UNEP.

TABLE 4.4.1: AIR QUALITY MONITORING FOR NOISE, REL. HUMIDITY, TEMP, WIND SPEED/DIRECTION

S/N	Sampling Points	Coordinates		Elevation (m)	Air Temp. °C	Wind Speed (m/s)	Relative Humidity (%)	Noise Level (dBA)
		E	N					
1	AQ1	199474.584	556826.083	8.69	33.1	1.3	50.4	37.4
2	AQ2	199532.187	556768.069	8.39	33.1	1.3	47.7	50.0
3	AQ3	199567.810	556699.918	10.08	32.3	1.4	47.1	58.0
4	AQ4	199578.590	556651.363	9.75	33.0	1.3	53.9	50.0
5	AQ5	199474.169	556625.071	8.75	31.5	1.3	52.7	50.0
6	AQ6	199438.014	556533.202	8.37	32.3	1.3	61.3	54.5
7	AQ7	199347.733	556479.258	7.31	30.3	1.3	60.4	63.7
8	AQ8	199280.590	556633.052	9.25	30.1	1.3	65.2	55.5
9	AQC1	199483.204	556844.326	8.76	30.0	1.3	65.6	56.0

NOISE LEVEL MEASUREMENT WITHIN THE PROJECT LOCATION

The noise measurements within the project location were conducted and are presented below. The noise levels ranged from 37.4 – 63.7*d*B(A).

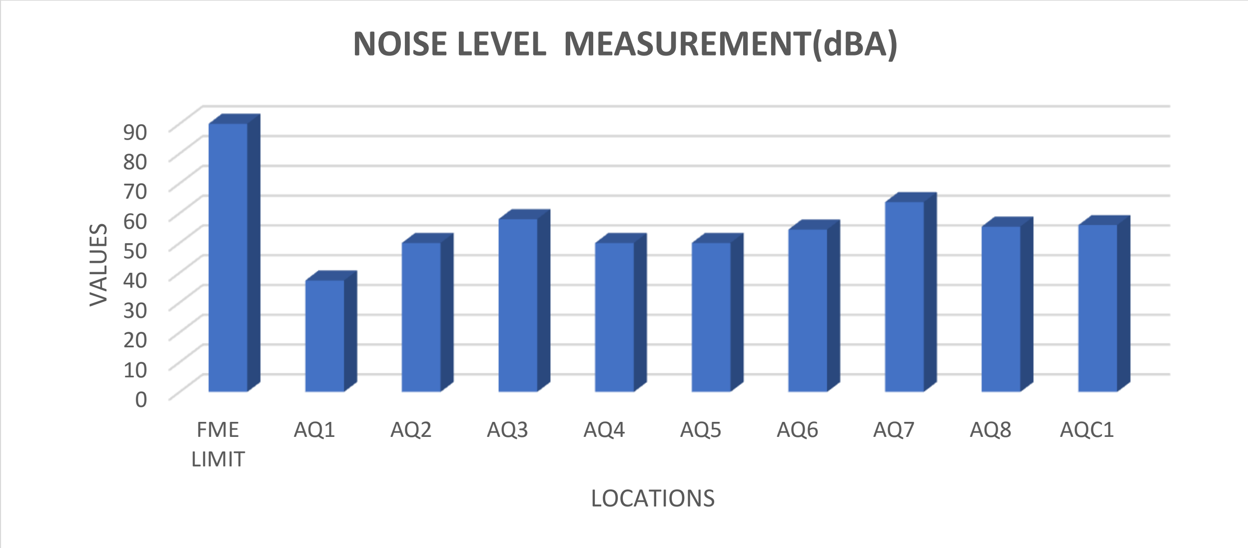

FIG 4.9 : NOISE LEVEL MEASUREMENT WITHIN STUDY AREA **SOURCE : FIELD WORK**

TABLE 4.4.2 : GASEOUS AIR POLLUTANTS MEASUREMENT

S/N	Sampling Points	NO_2 (µg/m^3)	SO_2 (µg/m^3)	H_2S ((µg/m^3)	CO, (µg/m^3	NH_3 PPM	PM (µg/m3)	VOC mg/m^3	CO_2 PPM	CH_4 PPM
1	AQ1	BDL	<0.01	0	0	0.0	14	0.959	763	0.01
2	AQ2	BDL	<0.01	0	0	0.0	14	0.763	723	0
3	AQ3	BDL	<0.01	0	0	0.0	10	0.612	721	0
4	AQ4	BDL	<0.01	0	0	0.0	18	0.542	707	0
5	AQ5	BDL	<0.01	0	0	0.0	16	0.554	731	0
6	AQ6	BDL	<0.01	0	0	0.0	14	0.512	711	0
7	AQ7	BDL	<0.01	0	<0.01	0.0	14	0.514	700	0
8	AQ8	BDL	<0.01	0	0.01	0.0	13	0.517	715	0
9	AQC1	BDL	<0.01	0	0.012	0.0	17	0.959	763	0

Notes: NS - No Specification; FMENV: Federal Ministry of Environment.
µg/m^3: Microgram per cubic meter; PPM: Parts Per Million; BDL: Below Detection Limit

REMARKS

All the gases analyzed in the above-mentioned locations were within their respective limits as at the time of measurement.

NITROGEN IV OXIDE

Nitrogen IV Oxide is a product of high temperature combustion like vehicle engines, domestic fires and industrial combustions. Studies have shown that man or animal exposure to NO_2 concentration above 0.563ppm may cause pulmonary diseases and increased susceptibility to bacterial infection (ACGIH, 1995). NO_2 acts mainly as an irritant affecting the mucosa of the eyes, nose, throat, and respiratory tract. The continuous exposure to high NO_2 levels can contribute to the development of acute or chronic bronchitis and may cause increased bronchial reactivity in some asthmatics, decreased lung function in patients with chronic obstructive pulmonary. The values recorded within the project location were below detection limit (BDL).

SULPHUR IV OXIDE (SO_2).

Sulphur IV Oxide (SO_2) amongst the Sulphur acidic oxides is a more important oxide of Sulphur as a primary pollutant and is formed from the oxidation of Sulphur containing fuels. Exposure to SO_2 at concentrations above 13.0ppm could stimulate broncho-constriction (as in asthma), mucus secretion, and eye irritation in man and other animals. The value of SO_2 recorded were below detectable limit (<0.01).

CARBON MONOXIDE

Carbon monoxide (CO) is the most common air pollutant. It is a colourless, odourless, tasteless and poisonous gas produced by the incomplete combustion of carbonaceous materials or fossil fuels (gas, oil, coal and wood). Adverse health effect has been observed with CO concentrations of 12–17mg/m^3 for 8 hours (Richard and John, 2012) while prolonged (45 minutes to 3 hours) exposure to concentrations between 200mg/m^3 and 800mg/m^3 often results in severe headache, dizziness, nausea and convulsions (Derek, 2013). It also induces fatigue, impairs alertness, inhibits foetal development and aggravates cardiovascular diseases. The value of carbon monoxide recorded ranged from 0.0-0.012ppm.

HYDROGEN SULPHIDE

Hydrogen Sulphide (H_2S) is a toxic, odorous, and corrosive gas, which is rapidly oxidized to Sulphur dioxide in the atmosphere. It can be present in natural gas in certain areas and can be released by sulphate reducing bacteria in certain aquatic environments. Exposure to excessive concentrations can be fatal and injurious to health. Sustained exposure to H_2S gas above 500mg/m^3 could result in death (Derek, 2013). Hydrogen Sulphide was not detected.

VOLATILE ORGANIC COMPOUNDS(VOCs)

VOCs are released into the atmosphere by anthropogenic and natural emissions. They include a variety of chemicals, some of which may have short and long term adverse health effects although higher indoors than outdoors, VOCs are emitted by a wide range of products which include but not limited to, paint, paint strippers, cleaning supplies, pesticides, building materials, office equipment (printers, copiers, correction fluids etc.), photographic solutions, fuels, disinfectants, etc. The health effects of VOC's vary from those which are highly toxic to those with no known health effect and this may also be dependent on the level of exposure. Eye and respiratory tract infections, dizziness, impaired memory as well as visual disorders are among immediate symptoms experienced soon after exposure to some organics. The values of VOC recorded ranged from 0.512ppm & 0.959ppm.

CARBON IV OXIDE (CO2)

Carbon IV Oxide (CO_2) is a greenhouse gas that is naturally occurring and harmless in small quantities, it becomes harmful to health and environment. Carbon iv oxide is given off during breathing. There is a natural level of its occurrence and when the threshold is exceeded it becomes harmful to the environment, which leads to greenhouse effect. Green plants make use of carbon dioxide to produce starch during photosynthesis in the presence of sunlight. The values of CO_2 recorded ranged from 700 & 763μg/m^3.

4.9 SOIL STUDIES/CHARACTERISTICS

Soils in Bayelsa State are varied per the geological history and soil formation processes in the different localities. The study location is characterized by a typical freshwater ecology of the upper reaches of the River Nun and Taylor creek within the Yenagoa, Bayelsa State. The study area lies within the outcropping Benin Formation made up of continental deposits of Miocene to recent sediments. The area is associated with freshwater swamps, backswamps and meander belts of flat to sub-horizontal elevation. The well drained clay soils of the hill crest and slopes are very important because they provide the best soils for the cultivation of food crops in the state. The lighter loams are more suitable for cultivation the local food crops, such as yam, cassava, potato, plantain, and maize. Soil degradation and soil erosion are generally not serious in the project area.

The soil in the project location is predominantly loamy soil with clay, rich in iron content which makes it good for agricultural purpose. There is sedimentary rock composition, which helps to support savannah vegetation. Eighteen (18) soil samples were collected from each of the nine (9) sampling points with the aid of a Dutch Hand Auger, hand gloves, a spool and hammer. Thus, most of the soil nutrients useful to plants and soil micro-organisms are concentrated at these depths. The samples for microbiological analysis were collected in McCartney bottles and stored in an ice chest. Samples for physicochemical analysis were collected in polythene bags. Nine (9) soil samples at depths of 0-30cm were collected within the project area.

PLATE 4.3 : CONSULTANT REPRESENTATIVE CONDUCTING SOIL SAMPLING WITH HAND AUGER

4.9.1 SOIL FAUNA

Life in the soil is diverse ranging from microscopic single celled organisms to large burrowing animals. Hence there are well-defined food chain/energy flows within the soil ecosystem. The soil macro-fauna encountered within the study area include various arthropods (insects, millipedes, mites, butterfly), annelids (earthworms) and nematodes. These organisms are primary consumers; decomposers, mixers and utilizers of energy stored in plants and plant residues, and contribute to the re-cycling of nutrients. Others were secondary consumers such as centipedes and spiders. These animals consume smaller sized animals and they may also serve as food for organisms occupying higher levels of the food chain.

The soil fauna of special interest within the savannah ecosystem under study were termites, lizards, butterflies, rodent, earthworms etc. The importance of earthworms to soil includes aeration, improvement of texture, mixing (materials from the surface taken to lower depths and vice versa) and nutrient re-cycling. Currently, 16 genera of earthworms have been described in Nigeria, and of these, seven occur in the Savannah ecosystem (Segun, 1980). However, three genera (Hyperiodrilus, Ephyriodrilus and Eudrilus) were encountered in the present study.

4.9.2 SOIL MICROORGANISMS

The micro-organisms and macro-fauna work together as a team in organic matter decomposition. The micro-organisms of concern in this study were fungi and bacteria and these play important roles in the transformation of soil nutrients.

PLATE 4.4: LIVING ORGANISMS WITHIN THE PROJECT LOCATION

PLATE 4.5: LIVING ORGANISMS WITHIN POLAKU COMMUNITY

TABLE 4.3. LIST OF ANIMALS IN THE STUDY AREA

S/N	SCIENTIFIC NAME	COMMON NAME	METHOD OF REPRODUCTION
1	Bufo Regularis	West African toad	Oviparity
2	Hemidactylus Brooki	Wall gecko	Oviparity
3	Varanus Niloticus	Nile monitor lizard	Oviparity
4	Mantis Religiosa	Praying mantis	Oviparity
5	Lepus Capensis	Cape Hare	Viviparity
6	Xerus Erythropus	West African Ground Squirrel	Viviparity
7	Lemniscomys Straitus	Spotted grass mouse	Viviparity
8	Rattus natalensis	Giant rat	Viviparity

9	Petronia Dentata	Bush sparrow	Oviparity
10	Gatrocantha sp	Spider	Oviparity
11	Agama Agama	West African rainbow lizard	Oviparity
12	Macrotermis Bellicosus	Termites	Oviparity
13	Orthetrum Branchiale	Dragonfly	Oviparity
14	Acraea terpicore	Butterfly	Oviparity
15	Anopheles sp	Mosquito	Oviparity
16	Nectarinia Cuprea	Copper Sunbird	Oviparity
17	Capra aegagrus hircus	Goat	Ovoviviparity
18	Canis lupus familiaris	Dog	Ovoviviparity

TABLE 4.4: SOIL SAMPLING COORDINATE LOCATIONS

SOIL SAMPLES COORDINATES					
S/N	**SAMPLE DESCRIPTION**	**SAMPLING DEPTH**		**COORDINATES(UTM)**	
		0-15cm	**15-30cm**	**N: (m)**	**E: (m)**
1	SS1	0-15cm	15-30cm	556822.1	199477.9
2	SS2	0-15cm	15-30cm	556562.1	199503.3
3	SS3	0-15cm	15-30cm	556667.5	199358.3
4	SS4	0-15cm	15-30cm	556701.8	199300.6
5	SS5	0-15cm	15-30cm	556709.8	199328.2
6	SS6	0-15cm	15-30cm	556582.8	199360.1
7	SS7	0-15cm	15-30cm	556599.6	199432.9
8	SS8	0-15cm	15-30cm	556613.4	199468.7
9	CSS	0-15cm	15-30cm	556844.3	199483.2

SS: Soil Sample **CSS: Control Soil Sample**

PLATE 4.6: SOIL AUGER

4.9.3 RESULTS OF LABORATORY ANALYSIS OF SOIL SAMPLES

4.9.3.1 SOIL TEXTURE AND COLOUR

The physico–chemical characteristics of soils samples in both top and bottom obtained during the study of the proposed project areas are presented below. The soils of the proposed project area were generally sandy-clay-loam to sand. The textural distribution varies from sand to sandy, clay, silt from surface to sub-soil indicating a fertile soil for agriculture. The colour of the soil samples varies from yellow, light brown, dark brown and black.

4.9.3.2 SOIL PARTICLE SIZE AND DISTRIBUTION

The table 4.5 below shows the soil particle size, types, and distribution.

TABLE: 4.5: SOIL PARTICLES DISTRIBUTION

S/N	SAMPLE ID	PARTICLE SIZE DISTRIBUTION ASTM 2487-92		
		Sand (%)	Silt (%)	Clay (%)
1	SS1 0-15cm	95.80	4.20	0.00
2	SS1 15-30cm	97.10	2.80	0.00
3	SS2 0-15cm	15.91	21.00	62.80
4	SS2 15-30cm	7.40	22.50	71.10
5	SS3 0-15cm	97.20	2.80	0.00
6	SS3 15-30cm	96.54	3.45	0.00
7	SS4 0-15cm	9.30	52.36	38.34

8	SS4 15-30cm	3.51	46.67	49.82
9	SS5 0-15cm	97.07	2.93	0.00
10	SS5 15-30cm	84.33	15.67	0.00
11	SS6 0-15cm	2.39	69.27	28.34
12	SS6 15-30cm	3.02	67.66	29.32
13	SS7 0-15cm	2.45	74.97	22.58
14	SS7 15-30cm	4.10	70.64	25.26
15	SS8 0-15cm	2.93	20.16	66.91
16	SS8 15-30cm	2.64	29.16	68.20
17	SS9 0-15cm	2.48	22.23	75.29
18	SS9 15-30cm	2.11	28.60	75.72

4.9.3.3 PHYSICO-CHEMICAL PARAMETERS OF THE SOIL SAMPLES

The laboratory physico-chemical parameters of the soil samples are shown below.

TABLE: 4.6: PHYSICOCEHEMICAL PARAMETERS OF SOIL SAMPLES

S/N	Sample ID	PH APHA 4500H	Cond APHA 4500 mg/kg	SO4 APHA 4500 mg/kg	NO_3 APHA 4500 mg/kg	NO_2 APHA 4500 mg/kg	TN APHA 4500 mg/kg	NH_3 APHA 4500 mg/kg	TOC APHA 4500 (%)
1	SS1 0-15cm	6.1	14	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1
2	SS1 15- 0cm	5.9	17	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1
3	SS2 0-15cm	5.6	6.0	4.0	0.05	0.002	1.0	0.49	3.10
4	SS2 15- 0cm	5.7	8.0	4.0	0.04	0.002	1.1	0.36	2.38
5	SS3 0-15cm	5.8	12	<1.0	<0.01	<0.001	<0.1	<0.01	2.42
6	SS3 15-0cm	5.8	25	<1.0	<0.01	<0.001	<0.1	<0.01	2.22
7	SS4 0-15cm	5.5	32	2.0	0.04	0.001	0.6	0.27	1.58
8	SS4 15-0cm	5.5	35	2.0	0.06	0.001	0.8	0.36	1.63
9	SS5 0-15cm	6.5	10	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1
10	SS5 15-0cm	5.7	6.0	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1
11	SS6 0-15cm	5.6	56	3.0	0.08	0.003	1.2	0.53	1.73
12	SS6 15-0cm	5.8	84	4.0	0.09	0.004	1.2	0.53	1.56
13	SS7 0-15cm	6.1	100	2.0	0.05	0.002	0.7	0.36	1.81
14	SS7 15-0cm	6.0	105	2.0	0.05	0.003	0.8	0.36	1.53
15	SS8 0-15cm	5.8	20	2.0	0.04	0.002	0.6	0.27	1.69
16	SS8 15-0cm	5.6	18	2.0	0.06	0.002	0.9	0.40	1.82
17	SS9 0-15cm	5.0	74	4.0	0.06	0.004	0.6	0.27	<0.1
18	SS9 15-0cm	5.0	68	2.0	0.06	0.004	0.8	0.36	<0.1

pH*:* The degree of acidity or alkalinity is usually considered a master variable that affects nearly all soil properties – chemical, physical and biological. pH influences aggregate stability as well as air and water movement in the soil. The amount of acid or alkali in the soil determines the availability of many nutrients for plant growth and maintenance. If the soil-pH is too high or too low, the nutrients are either locked onto the soil particles or are washed out of the soil. Most plants grow best when the soil-pH is between 5.5 and 6.5 (i.e., from the slightly acidic side to neutral).

The pH values of the surface subsurface (0 – 30cm) soils of the study area showed that the soils are slightly acidic with values that range from 5.0- 6.5 for the sub-surface.

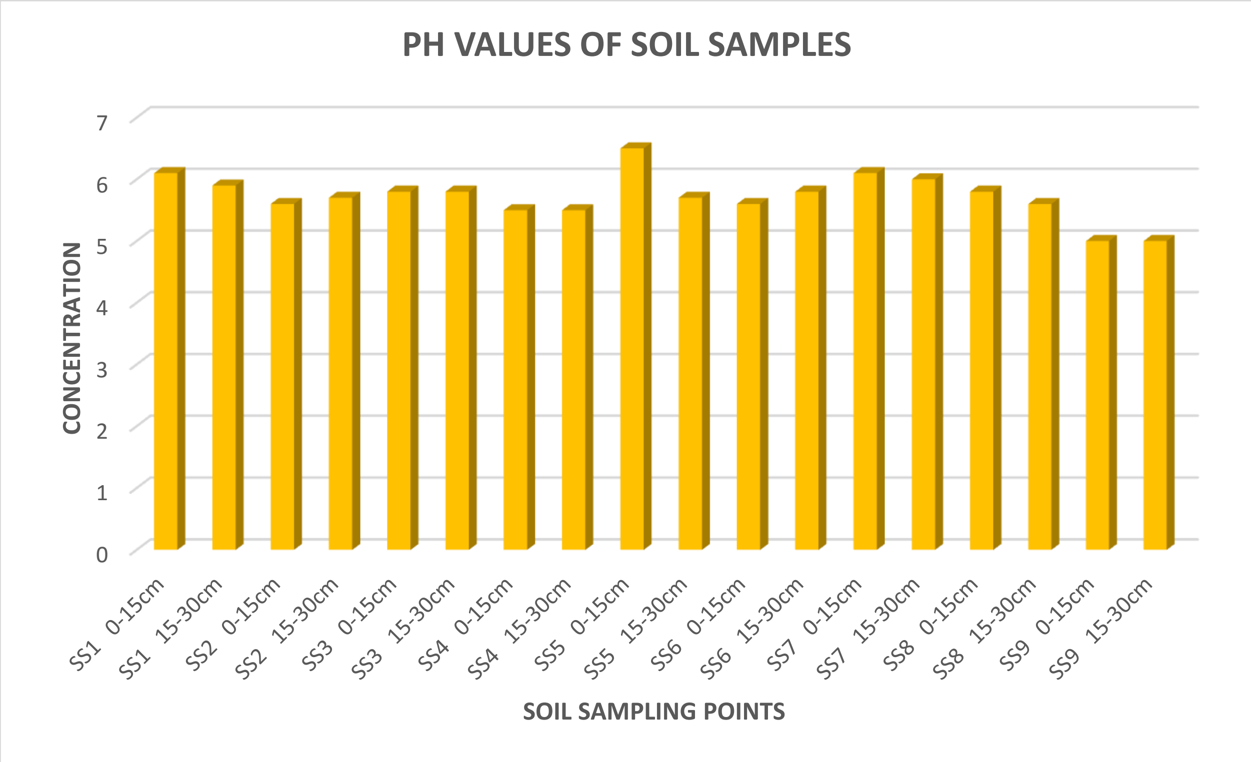

FIG 4.10: PH VALUES OF SOIL SAMPLES

Electrical Conductivity: Electrical conductivity is a measure of the electric current carrying ability of an aqueous solution. This is determined by the ionic content and ion exchange capacity of the substance (soil in this case) in aqueous solution (KWW, 2001). The electrical conductivities of the range in subsurface soils were 6.0 – 105µS/cm.

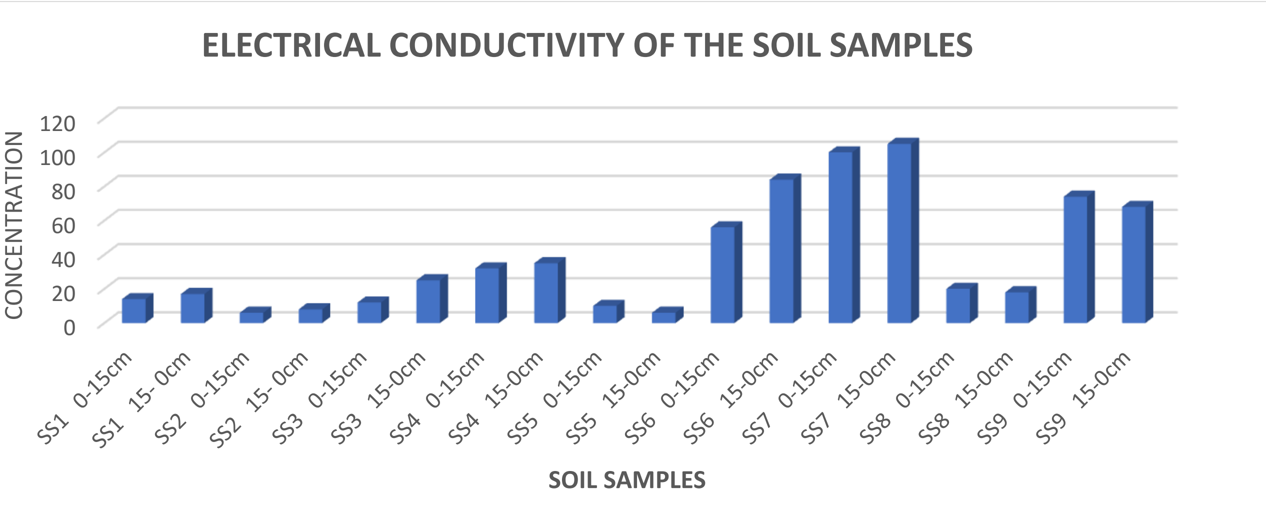

FIG 4.11: ELECTRICAL CONDUCTIVITIES OF THE SOIL SAMPLES.

Total Organic Carbon: Total Organic Carbon (TOC) level in the soil samples give an indication of a number of carbon-containing compounds and provides a means for determining the degree of organic contamination. High TOC content would result in increase in the growth of micro-organisms, which could contribute to the depletion of oxygen supplies (KWW, 2001). The TOC level for the subsurface soil samples ranged from <0.1% to 3.1%. The presence of dead decaying matter such as decaying vegetation observed on the surface of soil in the area may have accounted for the values of TOC in the surface than in the sub-surface.

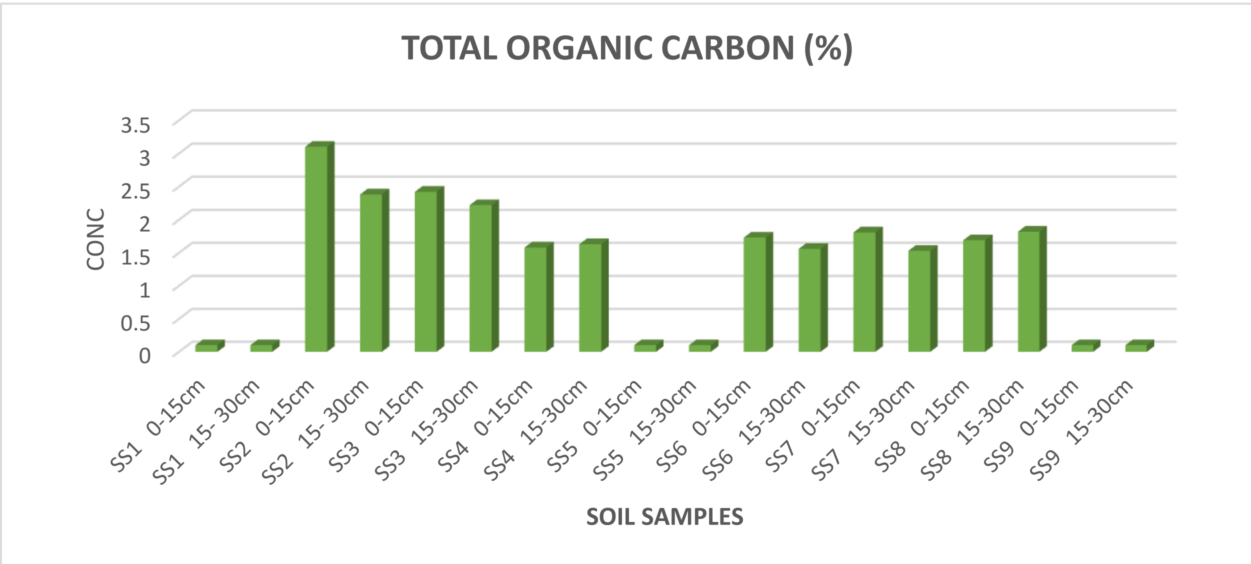

FIG 4.12: CONCENTRATION OF TOTAL ORGANIC COMPOUNDS IN THE SOIL SAMPLES

Nutrients: Nitrate concentrations in soil samples ranged in the subsurface layer nitrate ranged from <0.01– 0.09mg/kg. Total nitrogen in the subsurface ranged from <0.1 – 1.2mg/kg. Concentration of ammonium in the soil samples ranged from <0.01-

0.53mg/kg. Sulphate concentrations in soil samples in the subsurface layer ranged from <1.0-4.0mg/kg; nitrite ranged from <0.001– 0.004 mg/kg.

The importance of these nutrients in plants cannot be over-emphasized. Chlorophyll, plant proteins and nucleic acids are nitrogen compounds, which play major roles in plant growth. In addition, Phosphorous compounds are also key plant nutrients. They form an essential part of nucleo-proteins in plant cells and these control cell division and growth. Phosphorous is also a major constituents of deoxyribonucleic acid (DNA) molecules, which are the signature for genetic pools and inheritance characteristics of living organisms (Donahue *et al*., 1990). It is also part of energy storage and transfer of chemicals (Adenosine triphosphate, ATP) in plants. Sulphur occurs in proteins and is required for plant vitamins. It could be derived from rainfall and agricultural chemicals. Rainfall dissolves the sulphur oxides evolved during the burning of plant-derived fuels such as wood, coal, and oil. In acidic soils sulphur comes from mineralization of organic matter, particularly weathered soil (Donahue et al., 1990).

Heavy Metals

The concentrations range of heavy metals for surface and subsurface soil samples (Cr, Fe, Hg, Mn, Ni, Pb, Cu, Zn, and V) in the study area are presented below:

Chromium*:* The concentration of total Chromium is <<0.001-0.601mg/kg for subsurface soil.

Total Iron*:* The surface soil of the iron level ranged from 3288-33455 mg/kg. The soil samples are rich in iron which accounts for the good agricultural yield within the community.

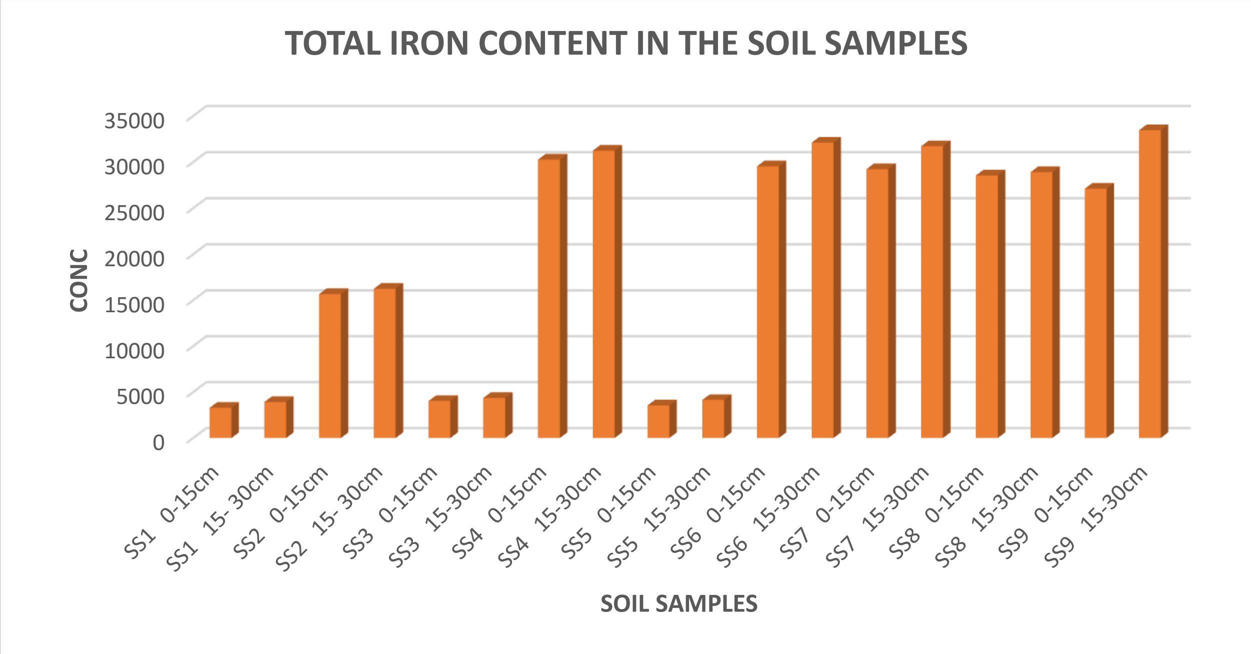

FIG 4.13: CONCENTRATION OF TOTAL IRON CONTENTS IN THE SOIL SAMPLES

Mercury: The concentration of Mercury was below equipment detectable limit of <0.001mg/kg subsurface soil.

Manganese*:* The manganese level of the subsurface soil has a value range <0.001-0.382mg/kg.

Nickel: The recorded values for nickel in the soil samples ranged from <0.001-3.524mg/kg

Lead: The concentrations of lead in the soil samples ranged from <0.001-73.91mg/kg.

Copper: The surface soil of the subsurface soil has values that ranged between 0.001-3.572mg/kg.

***Zinc**:* The concentration of zinc in the soil samples ranged from <0.001-58.12mg/kg.

Vanadium: The concentration of the metal was below equipment detectable limit of 0.001mg/kg subsurface soil.

MICROBIOLOGICAL STATUS OF SOILS

Results of microbial analyses of the soil samples are presented below. Results of Total Heterotrophic Bacteria Count (THB) for soil samples collected from 0 – 30cm depth have values that ranged from 1.2 – 2.0 x 10^2cfu/g.

TABLE 4.7: MICROBIOLOGICAL PROPERTIES OF SOIL SAMPLES

S/N	Sample ID	THB APHA 9215 Cfu/sg	THF APHA 9610 Cfu/g	HUB APHA 907 Cfu/g	HUF APHA 907 Cfu/g
1	SS1 0-15cm	$2.42x10^6$	$1.78X10^6$	$5.10X10^5$	$1.80X10^5$
2	SS1 15-30cm	$2.11x10^6$	$1.19X10^6$	$8.70X10^5$	$2.20X10^5$
3	SS2 0-15cm	$2.16X10^6$	$5.20X10^5$	$9.10X10^5$	$3.10X10^5$
4	SS2 15-30cm	$2.78X10^6$	$1.52X10^6$	$6.30X10^5$	$2.70X10^5$
5	SS3 0-15cm	$2.14X10^6$	$5.20X10^5$	$5.70X10^5$	$1.90X10^5$
6	SS3 15-30cm	$2.34X10^6$	$1.52X10^6$	$7.20X10^5$	$2.50X10^5$
7	SS4 0-15cm	$1.86X10^6$	$7.60X10^5$	$1.10X10^6$	$2.30X10^5$
8	SS4 15-30cm	$2.42X10^6$	$8.10X10^5$	$9.90X10^5$	$1.70X10^5$
9	SS5 0-15cm	$2.34X10^6$	$7.20X10^5$	$7.80X10^5$	$2.10X10^5$
10	SS5 15-30cm	$2.53X10^6$	$1.23X10^6$	$9.60X10^5$	$2.60X10^5$
11	SS6 0-15cm	$1.88X10^6$	$8.80X10^5$	$7.50X10^5$	$3.30X10^5$
12	SS6 15-30cm	$2.41X10^6$	$1.36X10^6$	$5.80X10^5$	$2.90X10^5$
13	SS7 0-15cm	$2.15X10^6$	$7.40X10^5$	$5.40X10^5$	$4.90X10^5$
14	SS7 15-30cm	$2.61X10^6$	$1.16X10^6$	$6.00X10^5$	$3.60X10^5$
15	SS8 0-15cm	$1.38X10^6$	$1.04X10^6$	$1.15X10^6$	$5.40X10^5$
16	SS8 15-30cm	$1.78X10^6$	$6.90X10^5$	$8.20X10^5$	$3.70X10^5$
17	SS9 0-15cm	$1.98X10^6$	$5.30X10^5$	$7.30X10^5$	$2.90X10^5$
18	SS9 15-30cm	$2.17X10^6$	$8.70X10^5$	$7.70X10^5$	$3.40X10^5$

Results of Total Heterotrophic Fungi Count (THF) for soil samples collected from 0 – 15 & 15- 30cm depth have values that ranged from $5.20X10^5$– $1.78X10^6$cfu/g. The values of HUB for the soil samples ranged from $5.10X10^5$- $1.15X10^6$cfu/g and the values of HUF the soil samples collected ranged from $1.70X10^5$-$5.40X10^5$. The values of THB of the soil samples ranged from $1.38X10^6$-$2.78X10^{6.}$

4.10 HYDROLOGY

Bayelsa State has a riverine and estuarine setting with many communities almost surrounded by water, making them inaccessible by road. Groundwater occurrence in Bayelsa State can be grouped into three. These are: weathered/fractured basement complex, newer basalts & river alluvium. In the basement complex that characterizes a significant portion of the geological structure of Bayelsa State, it is only possible to find water when the rock is decomposed/weathered, in such a way as to allow the infiltration of a certain amount of water within the rock joints. This determines the creation of an accumulation of water which is dependent on the degree of rock covering the impermeable rock. Thus, the main source of groundwater in crystalline rocks is the weathered zone or the fractured basement.

4.10.1 WATER RESOURCE STUDIES

In arid and semi-arid regions, the search for water which are under increasing stress from the growing human population, poses a great challenge due to its scarcity. Groundwater, as a dynamic system, is located beneath the Earth surface and moves under the control of many factors, which are influenced by forces that are dependent on hydrogeology, hydrology, and climatology. Recharge, as one of the factors controlling the situation and fluctuation of groundwater, is an important parameter that needs to be assessed more fully. Recharge, occurring in small and large scales, spatially and temporally, is influenced by several factors, such as meteorology, soil characteristics, geology, surface cover, slope, and depth of the groundwater level. Groundwater recharge estimation from precipitation is an integral part of hydrology and hydrogeology. Although, precipitation is the most important source of groundwater recharge the accuracy of currently attainable techniques for measuring recharge are not completely acceptable.

The source of surface water within the project area is the Taylor Creek and the Nun river which converged(confluence) Taylor creek within Polaku community.

PLATE 4.7 : CONCRETE LANDING JETTY WITHIN POLAKU COMMUNITY

PLATE 4.8 : TAYLOR CREEK & NUN RIVER WITHIN THE HOST COMMUNITY

PLATE4.9 : CONSULTANTS CONDUCTING GROUND WATER SAMPLING & INSITU MEASUREMENT

TABLE 4.8: PUBLIC HEALTH IMPACTS OF WATER PARAMETERS

PARAMETER	POTENTIAL IMPACT ON ENVIRONMENT
Turbidity, colour, taste and odour	Aesthetically offensive and impair light penetration – thus productivity and quality
Temperature	High temperatures harmful to aquatic life
DO	Fish and other aquatic organisms need DO in water to survive and lack of O_2 portends problem
BOD	As biodegradable organic matters are metabolized by bacteria and other microorganisms, oxygen is consumed. The microbes consume the DO in water and so reduce it. The extent to which they do this is the BOD. Therefore, BOD should not be too high.
COD	This is like BOD but refers to the metabolisation of all organics including non-organic substances. COD values are always higher than BOD values for the same sample.
TDS	May cause taste problems, hardness, corrosion, or aesthetic problems, if the TDS is too high.

TSS	Causes turbidity
Hardness	Hardness causes scale deposits in hot water pipes and difficulty in producing lather with soap. On the other hand, very soft water tends to increase corrosion problems in metal pipes, and, some health officials believe, the incidence of heart disease.
Fluorides	Contributes to good dental health in moderate amounts. Discolours teeth at higher concentrations.
Chlorides	Not harmful but have salty taste.
Sulphate	Has objectionable taste, may have laxative effects. In waste water can result in offensive odours from the formation of Hydrogen Sulphide. Also leads to corrosion in water pipes.
Nitrogen	Excessive nitrate concentrations in surface waters encourage the rapid growth of microscopic plants called algae; excessive growth of algae degrades water quality. This problem is called eutrophication.
Phosphorous	Like Nitrogen, phosphorous also leads to eutrophication in lakes. It has little effect on health in drinking water.
Toxic substances	The heavy metals Cd, Cr, Pb, Hg, Ag, Be, as also As and Se are toxic, that is, they are poisonous inorganic elements.
Coliforms and **E. coli**	Biological indicators of water pollution.

Source : Nathanson et al, 1997

4.10.2 GROUND WATER LABORATORY RESULTS

From the report of the geotechnical survey, groundwater was observed to be at about 1.20m in the borehole, details can be found in the borehole log Appendix 8. The ground water levels reported are the prevailing values at the time of investigation. It should be noted that ground water elevations are subject to tidal conditions, seasonal fluctuations and or flooding, considering these, it is possible for water levels to rise to shallower depths. Adequate considerations should be made in design and construction of structures.

Three ground water samples were taken for analysis by the ESIA study team. The ground water sampling was conducted at three points from boreholes within Polaku community in the presence of the FMENV Representatives monitoring the data gathering same day with soil sampling. The insitu parameter values for ground water a like pH, Electrical conductivity, temperature, TDS & dissolved oxygen were measured with the results as shown below. From the insitu measurement, the pH of the ground water samples were slightly acidic within the required range of (5.2-5.7), conductivity values ranged from 122.0-172 µS/cm dissolved oxygen values ranged from (4.2-7.8mg/L) and Total Dissolved Solids values ranged from (75-86mg/L).

TABLE 4.9 A: GROUND (BOREHOLE) WATER SAMPLE COORDINATES

S/N	GROUND WATER	SAMPLE DESCRIPTION	CO-ORDINATES (UTM)	
			E	N
1	BH1	Borehole water	198510	556704
2	BH2	Borehole water	198456	556722
3	BH3	Bore hole water	197900	557134

TABLE 4.9 B: INSITU PARAMETER READINGS FOR GROUND (BOREHOLE) WATER SAMPLES

Insitu Parameters	BH1	BH2	BH3	FME Limit
Temperature, °C	25.7	26.6	26.5	<40
Conductivity, µS/cm	122.0	172.0	172.0	NS
pH 25°C	5.6	5.2	5.7	6.0-9.0
Total Dissolved Solids, mg/L	75	86	84	2000
Dissolved Oxygen, mg/L	4.2	7.8	6.6	>2

BH: Borehole

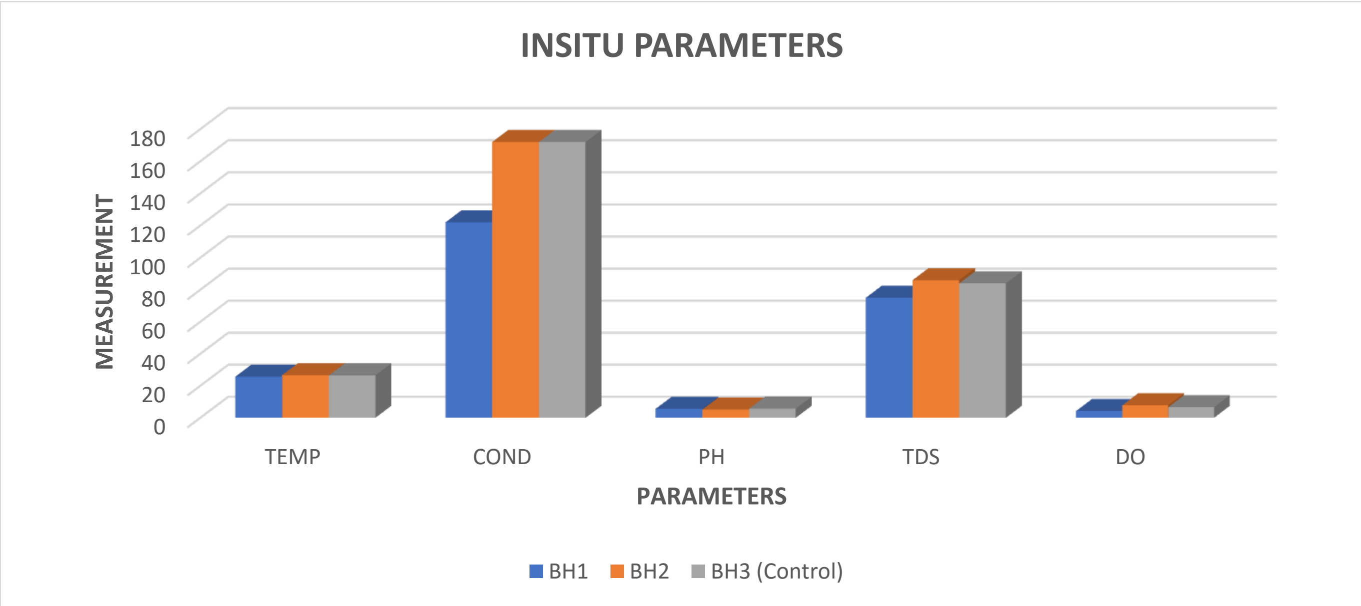

FIG.4.14: INSITU PARAMETERS OF GROUND WATER SAMPLES

TABLE 4.10 A: PHYSICOCHEMICAL LABORATORY ANALYSIS RESULT FOR GROUND WATER (BOREHOLE) SAMPLES

S/N	Sample ID	PH	Temp °C	TDS mg/l	Turbidity NTU	Colour Pt./Co	Chloride mg/l	Total Hardness mg/l	Alkalinity mg/l
1	BH 1	6.8	23.6	76	1.1	2	24.3	46	0.19
2	BH 2	7.2	23.2	47	0.9	1	14.2	48	0.12
3	BH 3	6.8	23.0	60	1.2	2	21.6	46	0.22
MEAN		**6.9**	**23.26**	**61**	**1.1**	**1.7**	**20.03**	**46.7**	**0.18**

S/N	Sample ID	TSS mg/l	COD mg/l	SO_4 mg/l	NO_3 mg/l	NO_2 mg/l	NH_4 mg/l	N mg/l
1	BH 1	2	1.0	<1	0.03	<0.01	0.05	0.11
2	BH 2	2	1.0	<1	0.07	<0.01	0.09	0.20
3	BH 3	2	1.0	<1	0.05	<0.01	0.06	0.13

mg/L: Milligram per Litre;
°C: Degree Centigrade
NSBC: No Significant Bacteria Count
THFC: Total Heterotrophic Fungi Count
CS: Control Sample
HUB: Hydrocarbon Utilizing Bacteria
µS/cm: Micro Semen per Centimetre
FNU: Formazin Nephelometric Units
THBC: Total Heterotrophic Bacteria Count
BDL: Below detectable limit
HUF: Hydrocarbon Utilizing Fungi

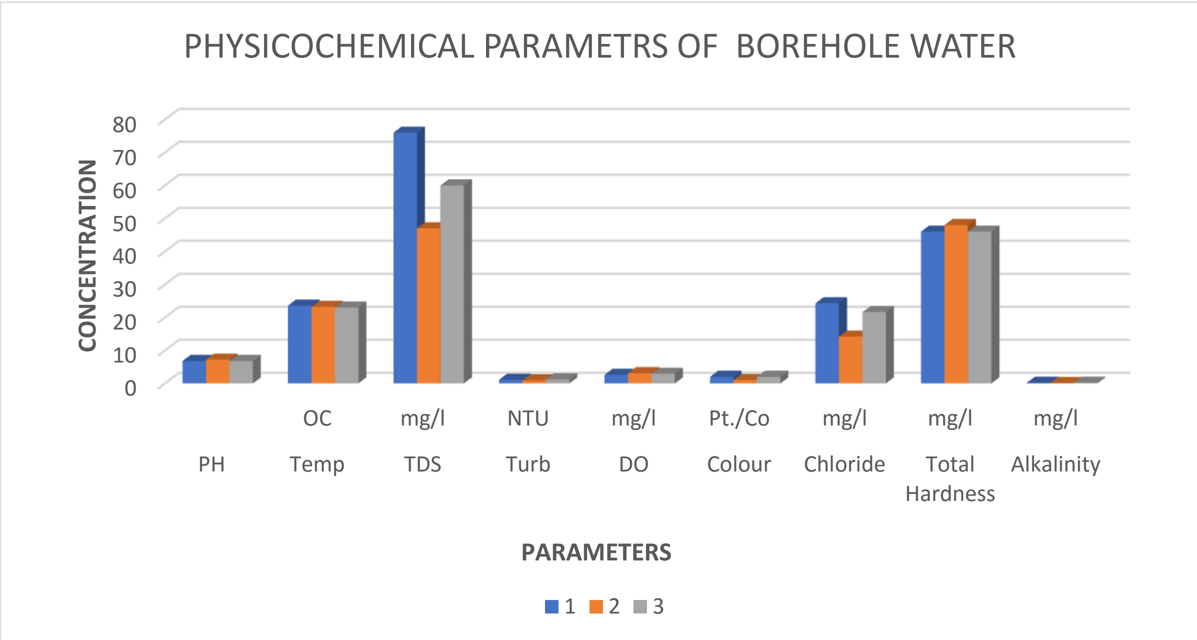

FIGURE 4.15: GROUND WATER PHYSICOCHEMICAL ANALYSIS

TABLE 4.11: PHYSICOCHEMICAL LABORATORY ANALYSIS RESULT FOR GROUND WATER (BOREHOLE) SAMPLES

S/N	Sample ID	THB Cfu/ml	HUB Cfu/ml	THF Cfu/ml	HUF Cfu/ml	T.Coliform (MPN/100 ml)	E.Coli (MPN/100 ml)

1	BH 1	$1.41X10^2$	$2.30x10^2$	$1.11X10^2$	NIL	180+	25
2	BH 2	$2.23X10^2$	$1.28x10^2$	$1.25X10^2$	$2.70X10^2$	180+	10
3	BH 3	$2.18X10^2$	$9.20x10^2$	$1.31X10^2$	$1.80X10^2$	180+	25

4.10.3 PARAMETERS OF WATER QUALITY (NATHANSON, 1997)

The parameters that measure the quality of water may be grouped into three, namely, physical, chemical, and microbiological.

PHYSICAL PARAMETERS

The physical parameters are turbidity, temperature, colour, taste and odour.

Turbidity: This is due to small particles suspended in water. The scattering and absorption of light from these particles gives water a murky or turbid look. Turbidity is measured in Nephelometric Turbidity Units (NTU). The typical ranges are as follows: for NTU less than 5, the water appears clear to the average person; For NTU between 5 and 25, water in a lake would appear clear to most people; for muddy water, NTU exceeds 200. Turbidity range was 0.9-1.2NTU in the samples analysis as shown in **Table 4.10A**.

Temperature: Fish and other aquatic organisms require certain levels of temperature to live and reproduce. The optimum temperature depends on the species of fish or organism and then on the chemical/physical nature of the water. The mean temperature of the borehole samples 23.36^{o}C.

Colour, Taste, and Odour: These are physical characteristics that are important for the quality of the water. Although they do not cause direct physical harm, most people would object strongly to water that offends their sense of sight, taste, and smell. Too much colour impairs light penetration in a body of water and could affect the food chain. The mean value for colour of the water samples was 1.7 Pt./Co.

CHEMICAL PARAMETERS

The chemical parameters are Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Hardness, asbestos or any dust system containing fibers of the correct size, namely 0.1 μ m diameter and 2-20μm long, the heavy Metals, Aluminum (Al), Iron (Fe), Manganese (Mn), Lead (Pb)), the eight trace elements, (As, Cd, Cu, Cr, Pb, Hg, Ni, and Zn). Trace elements are elements that are generally present only in small quantities in natural systems.

The other parameters are the anions (Fluorides, Chlorides, Sulphate, Nitrogen, Phosphorus), Acidity, Alkalinity and pH, Toxic and radioactive substances. The values of these parameters are as stated on the above table. The values of sulphate was <1mg/L, Nitrate values ranged 0.02-0.07mg/L, ammonium values ranged from 0.05-0.09mg/L, chlorides values ranged from 14.2-24.3mg/L.

Metals & Heavy metals

Iron content in the borehole water samples ranged from 0.109-0.573mg/L, Potassium ranged from 0.230-0.626mg/L, Sodium ranged from 3.227-5.321mg/L, Magnesium content values ranged from 0.162-0.185mg/L, Calcium contents values ranged from 0.358-0.381mg/L. The lead (Pb) contents ranged from <0.001-0.004mg/L, Zinc value was <0.001mg/L, Cadmium was <0.001mg/L, Nickel value was <0.001mg/L, Mercury was <0.001mg/L, Copper value was <0.001mg/L, Chromium was <0.001mg/L.

MICROBIOLOGICAL PARAMETERS

The microorganisms of interest are a group of bacteria called Coliforms and for human contamination we rely on Escherichia Coli (E. coli). The value of E. Coli ranged from 10-25(MPN/100 ml). The values of THB ranged from 1.41X10^2-2.23X10^{2}Cfu/ml, HUB values ranged from 1.28x10^2 - 9.20x10^2(Cfu/ml), THF results ranged from 1.11X10^2 -1.31X10^2 (Cfu/ml), and HUF values ranged from 1.80X10^2 - 2.70X10^2(Cfu/ml).

4.10.4 SURFACE WATER FROM TAYLOR CREEK/NUN RIVER

Four surface water samples were collected along the Taylor Creek(The control point at the upstream along Taylor creek, upstream at the confluence(Taylor Creek/Nun River), mid-stream at the proposed project site and down-stream after the project site.

TABLE 4:12: SURFACE WATER SAMPLE COORDINATES

S/N	SURFACE WATER	SAMPLE DESCRIPTION	CO-ORDINATES (UTM)	
			E	N
1	SW1-(Control Sample- Up stream)	Surface water	198488	556400
2	SW2- Up Stream (Confluence)	Surface water	199494	555856
3	SW3- Mid-Stream	Surface water	199065	556219
4	SW4- Down stream	Surface water	197732	557106

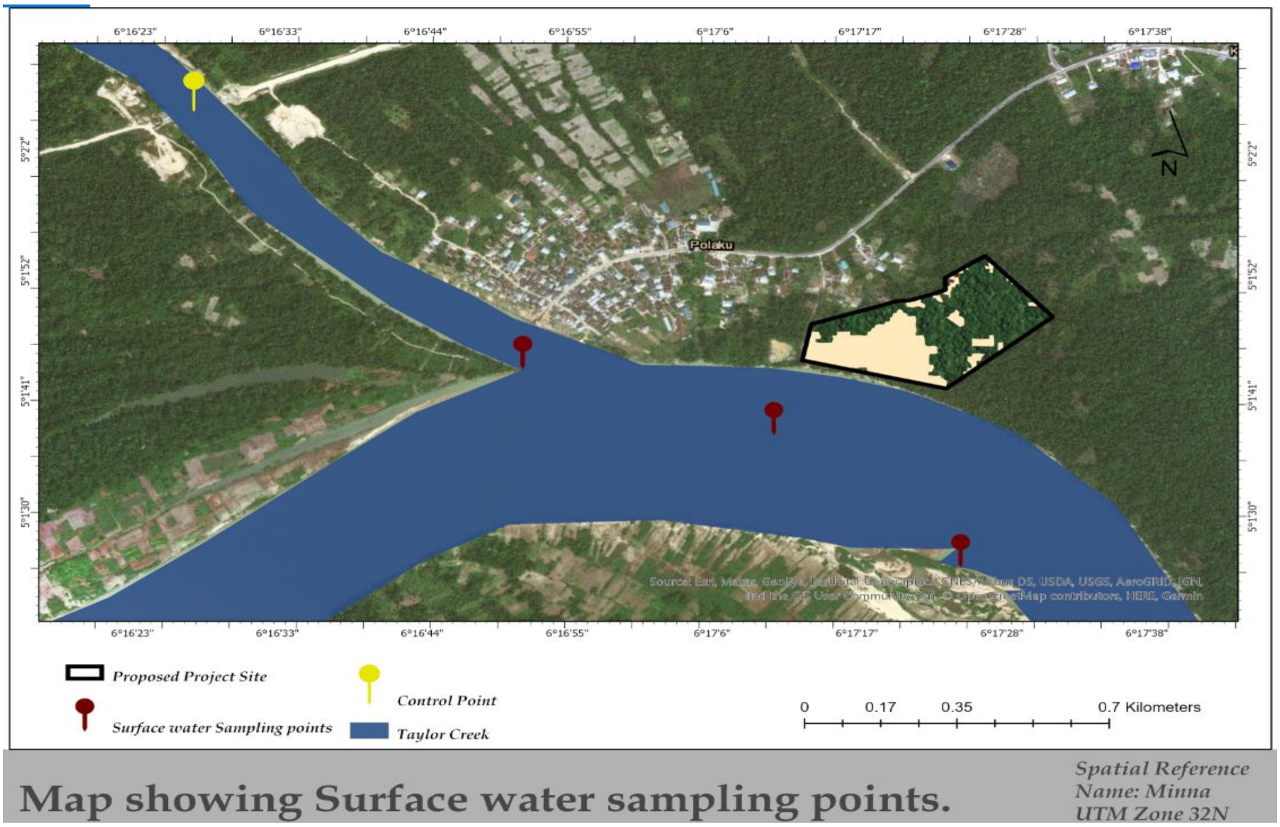

FIG. 4.16: SURFACE WATER SAMPLING POINTS

TABLE 4.13: SURFACE WATER INSITU PARAMETERS

Insitu Parameters	SW1 -Up stream (Control Sample)	SW2 Up Stream-Confluence	SW3 Mid-Stream	SW3 Down stream	FME Limit
Temperature, ^{o}C	28.2	28.4	27.5	26.6	<40

Conductivity, µS/cm	86.0	88.0	108	86	NS
pH 25^oC	6.7	6.8	5.4	6.1	6.0-9.0
Total Dissolved Solids, mg/L	44.0	44.0	52	43	2000
Dissolved Oxygen, mg/L	7.7	7.8	7.4	8.0	>2

SW: Surface water

TABLE 4.14: PHYSICOCHEMICAL LABORATORY ANALYSIS RESULT FOR SURFACE WATER SAMPLES

S/N	Sample ID	PH	Temp ^oC	TDS mg/l	Turb NTU	DO mg/l	Colour Pt./Co	NH_4 mg/l	N mg/l
1	SW 1	7.2	23.0	22	5.8	3.8	1	0.04	0.08
2	SW 2	7.2	22.6	22	6.3	3.7	1	0.03	0.06
3	SW 3	7.2	23.1	22	6.6	3.5	1	0.04	0.08
4	SW 4	7.2	23.3	23	6.2	3.7	1	0.04	0.08
MEAN VALUES		**7.2**	**23.0**	**22.3**	**6.3**	**3.7**	**1**	**0.04**	**0.08**

S/N	Sample ID	Chloride mg/l	Total Hardness mg/l	Alkalinity mg/l	TSS mg/l	COD mg/l	SO_4 mg/l	NO_3 mg/l	NO_2 mg/l	NH_4 mg/l	N mg/l
1	SW 1	8.9	38	0.08	18	0.0	<1	0.03	<0.01	0.04	0.08
2	SW 2	8.9	36	0.08	20	0.0	<1	0.03	<0.01	0.03	0.06
3	SW 3	8.9	38	0.08	12	0.0	<1	0.02	<0.01	0.04	0.08
4	SW 4	8.9	38	0.08	20	0.0	<1	0.03	<0.01	0.04	0.08
MEAN VALUES		**8.9**	**37.5**	**0.08**	**17.5**	**0.0**	**<1**	**0.028**	**<0.01**	**0.038**	**0.075**

S/N	Sample ID	THB Cfu/ml	HUB Cfu/ml	THF Cfu/ml	HUF Cfu/ml	T.Coliform (MPN/100 ml)	F.Coli (MPN/100 ml)
1	SW 1	$2.93X10^2$	$1.48x10^2$	$1.62X10^2$	$3.70X10^2$	180+	35
2	SW 2	$2.85X10^2$	$1.68x10^2$	$1.55X10^2$	NIL	180+	35
3	SW 3	$2.78X10^2$	$1.54x10^2$	$1.63X10^2$	$2.10X10^2$	180+	35
4	SW 4	$2.72X10^2$	$2.11x10^2$	$1.83X10^2$	$3.50X10^2$	180+	35

TABLE 4.14A: MICROBIOLOGICAL ANALYSIS RESULT FOR SURFACE WATER SAMPLES

4.10.5 PARAMETERS OF WATER QUALITY (NATHANSON, 1997)

The parameters that measure the quality of water may be grouped into three, namely, physical, chemical, and microbiological.

PHYSICAL PARAMETERS

The physical parameters are turbidity, temperature, colour, taste and odour.
Turbidity: The mean value of turbidity of the surface water samples was 6.2NTU.
Temperature: The mean value for surface water temperature was 23.0^{o}C.
Colour, Taste, and Odour: These are physical characteristics that are important for the quality of the water. Although they do not cause direct physical harm, most people would object strongly to water that offends their sense of sight, taste, and smell. Too much colour impairs light penetration in a body of water and could affect the food chain. The colour of the surface water was 1 Pt./Co.

CHEMICAL PARAMETERS

The chemical parameters are Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Hardness, asbestos or any dust system containing fibers of the correct size, namely 0.1 μ m diameter and 2-20μm long, the heavy Metals, Aluminum (Al), Iron (Fe), Manganese (Mn), Lead (Pb)), the eight trace elements, (As, Cd, Cu, Cr, Pb, Hg, Ni, and Zn). Trace elements are elements that are generally present only in small quantities in natural systems.
The other parameters are the anions (Fluorides, Chlorides, Sulphate, Nitrogen, Phosphorus), Acidity, Alkalinity and pH, Toxic and radioactive substances. The values of these parameters are as stated on the above table. The value of sulphate was <1mg/L, Nitrate values ranged 0.02-0.03mg/L, ammonium values ranged from 0.03-0.04mg/L, chloride value was 8.9mg/L.

Metals & Heavy metals

Iron content in the borehole water samples ranged from 0.985-1.461mg/L, Potassium ranged from 0.996-1.211mg/L, Sodium ranged from 0.056-0.063mg/L, Magnesium content values ranged from 1.121-1.219mg/L, Calcium contents values ranged from 0.347-0.361mg/L. The lead (Pb) contents ranged from 0.335-0.982mg/L, Zinc value was <0.001mg/L, Cadmium was <0.001mg/L, Nickel value ranged from <0.001-0.004mg/L, Mercury was <0.001mg/L, Copper values ranged from 0.114-0.282mg/L, Chromium was 0.011-0.078mg/L.

MICROBIOLOGICAL PARAMETERS

The microorganisms of interest are a group of bacteria called Coliforms and for human contamination we rely on Escherichia Coli (E. coli). The value of E. Coli ranged from 18-35(MPN/100 ml). The values of THB ranged from 2.12 x 10^2-2.93X10^2Cfu/ml, HUB values ranged from 1.32x10^2 – 1.68x10^2(Cfu/ml), THF results ranged from 1.42X10^2 -1.83X10^2 (Cfu/ml), and HUF values ranged from 0.0 -3.70 x 10^2(Cfu/ml).

4.11 LAND USE/COVER & OWNERSHIP

The land use pattern and land cover are driven by a variety of socio-economic, political, cultural, technological, and bio-physical factors. Land cover change is one of the most important variables of environmental change and represents the largest threat to ecological systems. Yenagoa as the Local Government Area playing host to the proposed project is characterized by remarkable growth in population, expansion and developmental activities which have resulted in increased land consumption and alteration of the land. The increasing concern for the management of natural resources in recent times has been necessitated by the increase in demographic pressure and its associated anthropogenic activities which have led to serious environmental stress and ecological instability.

The foremost land-use and cover of the proposed project area and the host community is forestry, agriculture, and built-up areas (the built-up areas are mainly settlements and low & medium scale businesses), and the water bodies (Taylor Creek & Nun River. Crop production in Bayelsa State is limited by the fact that much of the terrain is swampy and extensive areas of land are flooded for most of the year. Despite these constraints, food crops grown in the state include yam, cocoyam, banana, pineapple and plantain, but the shortage of agricultural land consequent on the ecological circumstances and environmental degradation constrain commercial production of the crops. The major cash crops grown in the proposed project area just like the State amongst others are coconut, pears, oil palm and raffia palm. The potentialities for the development of these crops to feed local industries are particularly good. Technology should be developed to reclaim land from mangrove swamps to cultivate food, especially lowland rice, and the cash crops on a large, commercial scale.

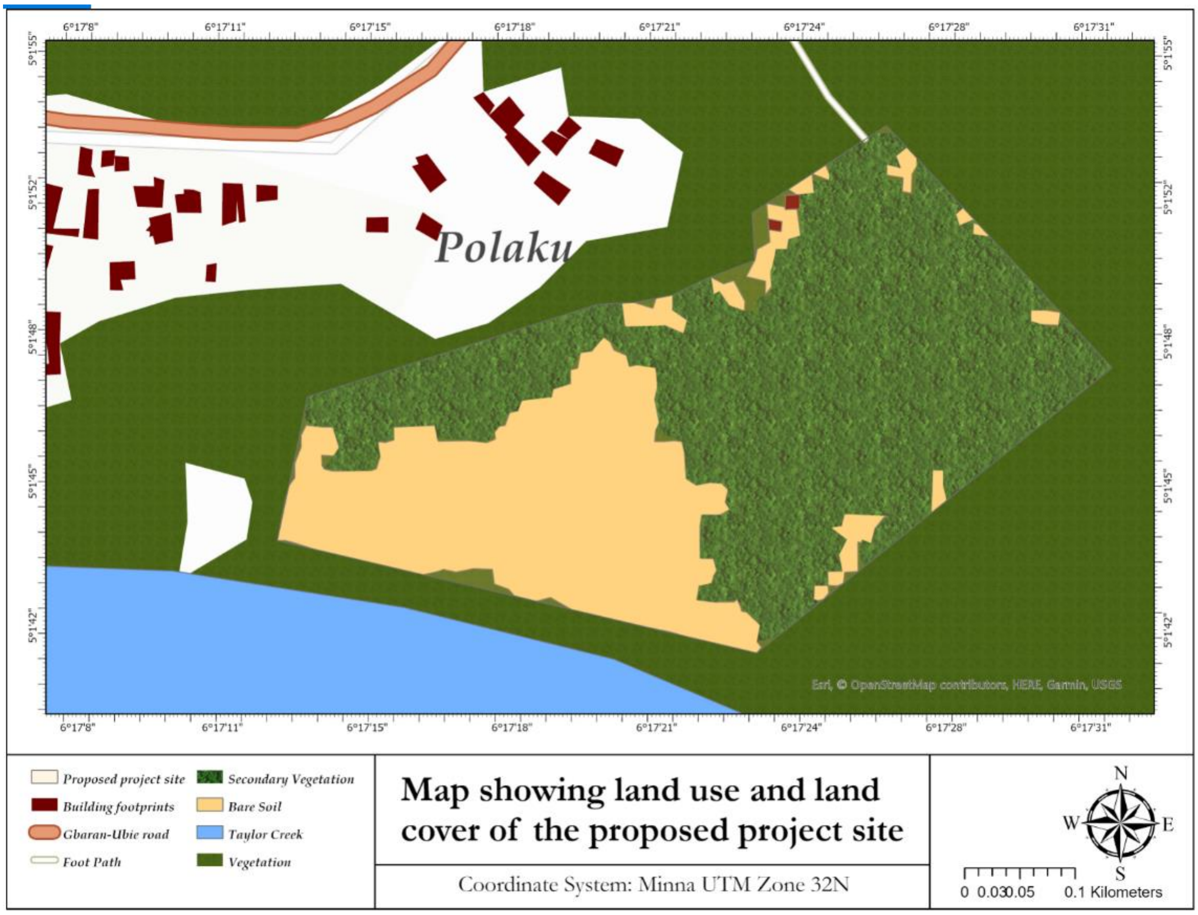

FIG 4.17: MAP SHOWING LAND USE & LAND COVER OF THE STUDY AREA
SOURCE: FIELD WORK

Various species of tropical trees grow in both the mangrove and freshwater swamps. Several timber species provide material for canoe building which is an important industry since canoes are the only means of transportation in much of the state. There is need to exploit the state’s forest products for paper and pulp, timber, canoe and boat building, toothpicks etc., but exploitation is problematic because of poor access roads.

The land use within Polaku is predominantly for farming, small scale businesses and housing development. Land ownership is freehold system within the Polaku community of Yenagoa, Bayelsa State.

The land use/land cover map of the proposed project site is presented in figure 4.17. The land cover classification was done using satellite imagery from Sentinel 2A L1C Tile in JPEG2000 format with geo-location of the proposed project area. Satellite Sentinel-2 imagery data set was available from United States Geological Survey (USGS), the Sentinel-2 data were acquired, processed, and generated by the European Space Agency (ESA) and repackaged by USGS.

The imagery used for this classification was acquired on the 10th of August 2020. The classified image shows different prominent land use and land cover types within the proposed project area. These are buildings (built-up areas), vegetation (secondary vegetation), and barren (bare soil). After classification the land use area occupied by each land use type was calculated and this indicated that the proposed project area is largely an undeveloped land with built-up area representing about 0.51%, vegetation cover which is mainly secondary growth about 61.67% and barren (bare soil) cover represent about 37.88% of the total land mass.

PLATE 4.10: HAND DUG FISH POND WITHIN POLAKU

PLATE4.11: BUILDING STRUCTURES WITHIN THE POLAKU COMMUNITY

4.11.1 FARMLANDS

The area under study is within the Polaku community, majority of the indigene are predominantly peasant farming and fishermen/women. They occurred as small cultivated plots and as plantations. The farmers cultivated crops such as pepper (Capsicum sp), sweet potatoes (Ipomea batatas), plantain (Musa Paradisiaca), groundnut (Arachis hypogea), banana (Musa Sapientum), cassava (Manihot esculenta), cocoyam (Colocasia esculenta), water yam (Dioscorea Alata), coconut (Cocos nucifera), okra (Hibiscus esculentus), sugarcane (Saccharum Officinarum), pineapples (Ananas comosus), maize (Zea Mays), and vegetables.

PLATE 4.12 A: PLANTAIN FARM WITHIN THE POLAKU COMMUNITY

PLATE 4.12B: SUGAR CANE WITHIN POLAKU COMMUNITY

PLATE 4.12C: POTATO PLANT WITHIN POLAKU COMMUNITY

PLATE 4.12D: CASSAVA PLANTATION WITHIN POLAKU

PLATE 4.12E: COCOYAM PLANTATION WITHIN POLAKU

PLATE 4.12 F: CITRUS(ORANGE) PLANTATION WITHIN POLAKU POLAKU

PLATE 4.12G: CITRUS(LIME) PLANTATION WITHIN

4.12 SITE'S NATURAL CHARACTERISTICS

The proposed site is on a sand-filled area within Polaku originally earmarked by the Nigerian Content Development & Monitoring Board (NCDMB) for industrial activities which is characterised by Rain Forest Zone with lots of vegetations, trees and food crops like, plantains, pineapple, cassava and other leguminous plants. The area is also a natural open space covered by natural indigenous vegetation which is suitable for agricultural purpose, but this has been designated as industrial hub. These areas play an important role in providing natural habitats for biodiversity within the landscape. The protection of these vegetation in a natural state will ensure the normal functioning of ecosystems.

PLATE 4.13: GRASSLAND WITHIN THE PROJECT SITE

4.12.1 THE BIOPHYSICAL ENVIRONMENT

The following components of the biophysical environment were investigated:

- Climate and meteorology
- Air quality and noise
- Vegetation
- Land use/cover
- Wildlife
- Geology and hydrogeology, including groundwater quality
- Soil quality
- Aquatic studies
- Hydrobiology and fisheries

PLATE 4.14: PHYSICAL STRUCTURES WITHIN THE STUDY AREA

4.13 TOPOGRAPHY, ECOLOGY AND GEOLOGY OF AREA

The topography of the proposed project location is flat, slopping gently towards the Taylor creek. The project area is on a low land. Various forms of morphological units and depositional environments have been recognised in the study area, ranging from coastal flats, sand bars, ancient/modern sea, river and lagoon beaches, flood plains, seasonal flooded depressions, swamps, ancient creeks and river channels. The geographical landscape of the area and the entire state comprises extensive fertile soil loamy soil suitable for agriculture, because of the presence of grasses it is suitable for cattle rearing and farming. The adjoining area is predominantly savannah ecosystem. There are also vast forest reserves, rivers, lagoons, rocks, mineral deposits. Geologically, extensive deposits of sandstone, mineral deposits occur within the Local Government and the State. A topographic map is a two-dimensional representation of the Earth’s three-dimensional landscape. It is a two-dimensional representation of a portion of the three-dimensional surface of the earth. Topography is the shape of the land surface, and topographic maps exist to represent the land surface. Using the ASTER DEM (Advanced Spaceborne Thermal Emission and Reflection Radiometer), the Digital Elevation Model of the proposed project area was extracted and used to compute the contour, hillshade, slope, aspect and aspect-slope map to determine its topographic features.

4.13.1 HILSHADE

Hillshading is a technique for visualizing terrain determined by a light source and the slope and aspect of the elevation surface. It is a qualitative method for visualizing topography. A Hillshade is a grayscale 3D representation of the surface, with the sun's relative position considered for shading the image. Elevation is the vertical distance from a datum (usually mean sea level) to a point or object on the Earth’s surface. A hillshade map was created to produce a 3D surface of the proposed project site using the elevation data. The elevation of the area ranged between 2m - 29m above sea level. The minimum elevation is 2 meters and the maximum elevation is 29 meters.

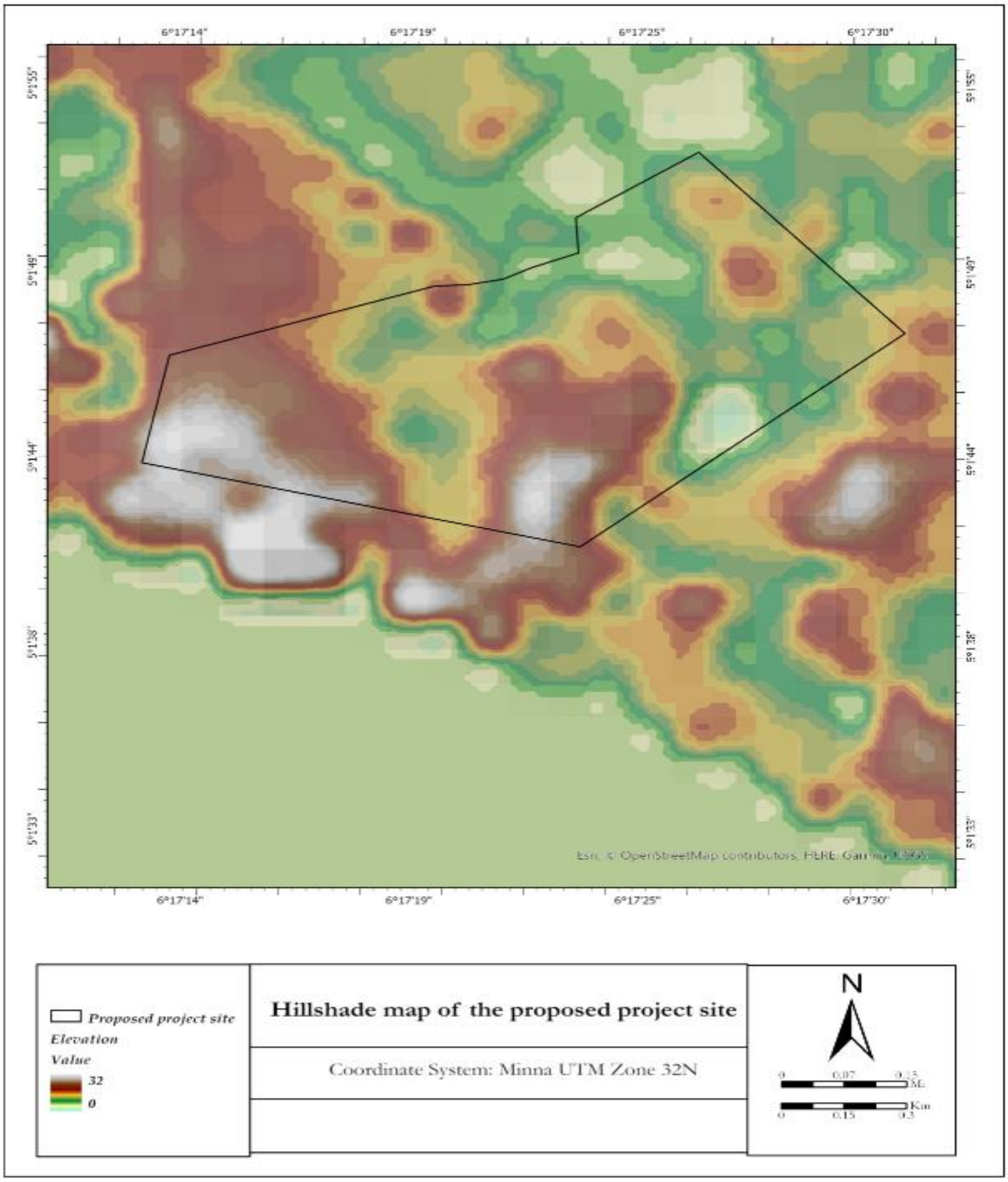

FIG 4.18: HILLSHADE MAP OF THE PROPOSED AREA
Source: Field work

4.13.2 CONTOUR

Contour lines are the principal means used to show the shape and elevation of the land surface. Contour lines connect a series of points of equal elevation and are used to illustrate relief on a map. They show the height of ground above mean sea level (MSL) either in metres or feet and can be drawn at any desired interval. For example, numerous contour lines that are close to one another indicate hilly or mountainous terrain; when further apart they indicate a gentler slope; and when far apart they indicate flat terrain.

The contour map representing the proposed area was produced with 3 metres interval. The contour map revealed that the area is mostly a flat terrain while the north-east and south-west area revealed a higher elevation around Taylor Creek. The darker contour hues (colour) represent high elevation areas while the lighter contour hues (colour) represent areas with lower elevation as seen on the map.

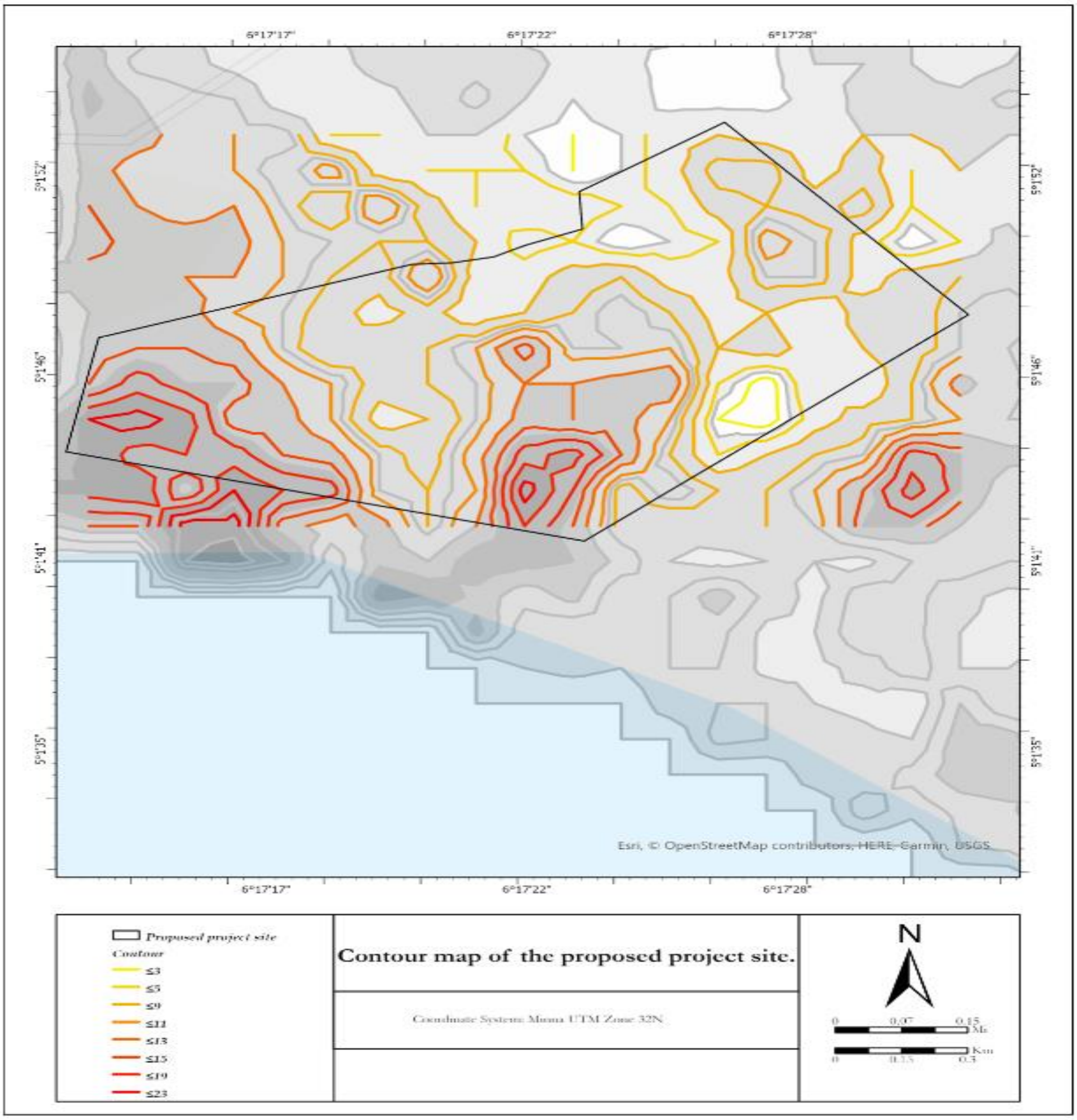

FIG 19: CONTOUR MAP OF THE PROPOSED AREA
SOURCE: FIELD WORK

4.13.3 SLOPE

A slope is the rise or fall of the land surface. Slope represents the rate of change of elevation for each digital elevation model (DEM) pixel. Slope is the rate of maximum change in z-value from each cell. Slope identifies the steepest downhill slope for a location on a surface. The range of values in the output depends on the type of measurement units. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope raster can be calculated as percent slope or degree of slope. For degrees, the range of slope values is 0 to 90. A degree slope was used for this project. From the output map, the proposed project site shows that the terrain is majorly flat. However, the terrain around Taylor creek in the south of the proposed project site have a steeper slope.

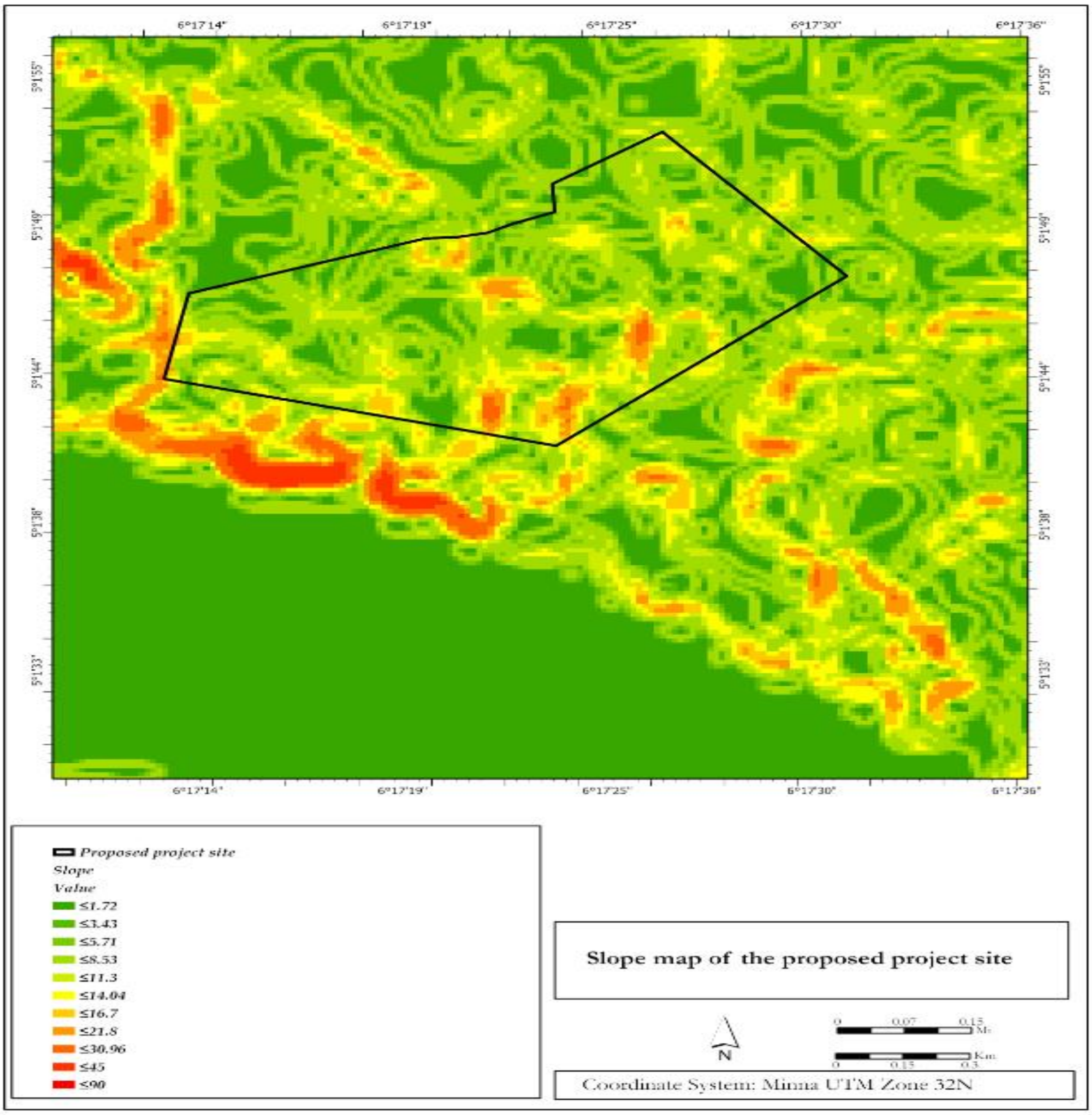

FIG 4.20: SLOPE MAP OF THE PROPOSED AREA
SOURCE: FIELD WORK

4.13.4 ASPECT

Aspect means the direction in which the land is facing north, south, east, or west. Aspect is expressed in positive degrees from 0 to 359.9, measured clockwise from north. Cells in the input raster that are flat—with zero slope—are assigned an aspect of -1. Aspect can be thought of as the slope direction. The values of the output raster are the compass direction of the aspect, represented by a hue (colour). The aspect map of the proposed project site shows the orientation of the downward sloping terrain (0° – 360°) which is indicated by different colours, rotating from red (North) to yellow (East), to blue (South) to orange (West). Flat areas having no down slope direction are given a value of -1° and rendered as grey.

4.13.4.1 ASPECT-SLOPE:

An aspect-slope map simultaneously shows the aspect (direction) and degree (steepness) of slope for a terrain (or other continuous surface). Aspect categories are symbolized using hues (e.g., red, orange, yellow, etc.) and degree of slope classes are mapped with saturation (or brilliance of colour) so that the steeper slopes are brighter.

The Aspect-Slope map shows the direction and steepness of the proposed project site.

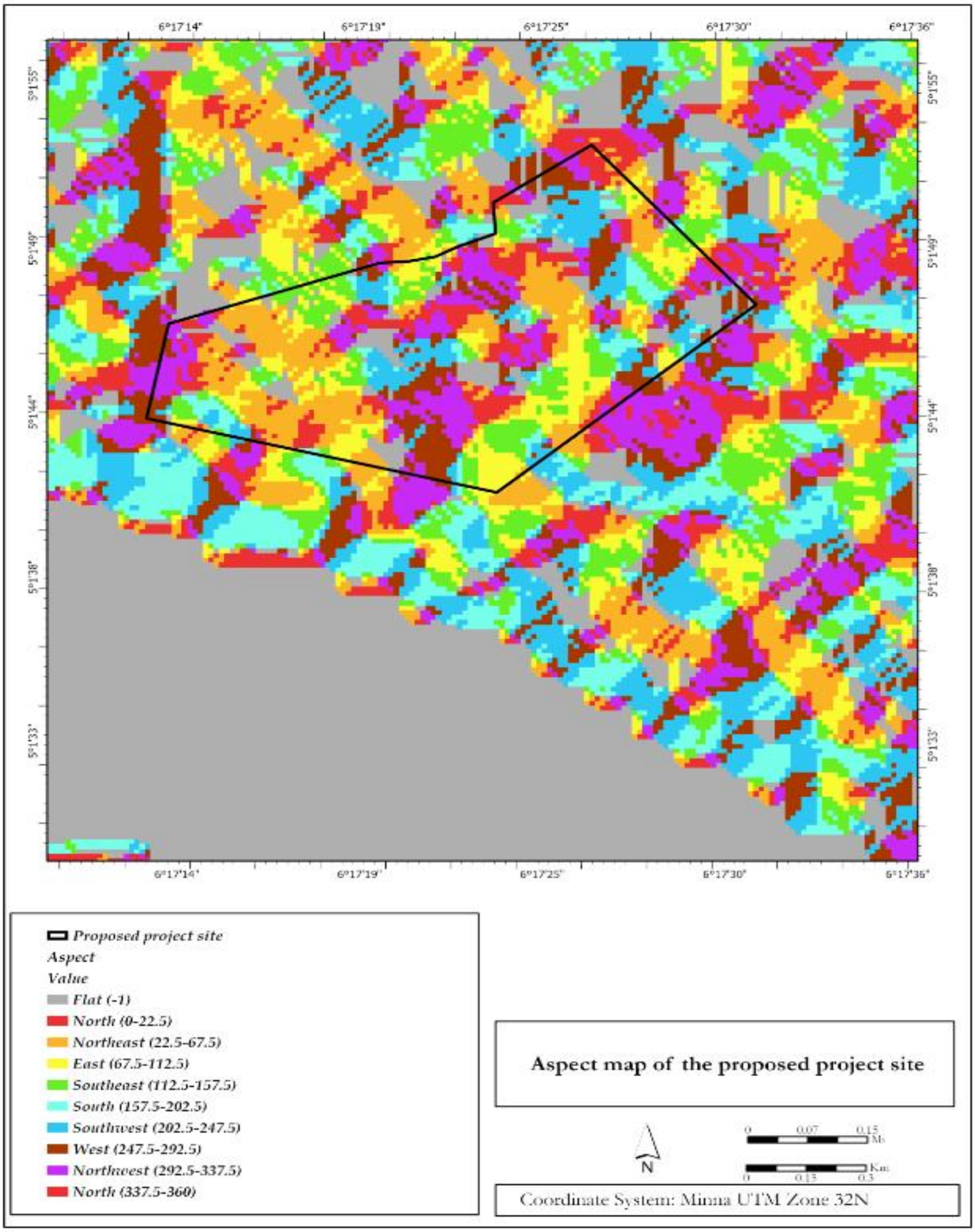

FIG 4.21: ASPECT MAP OF THE PROPOSED AREA
SOURCE: FIELD WORK

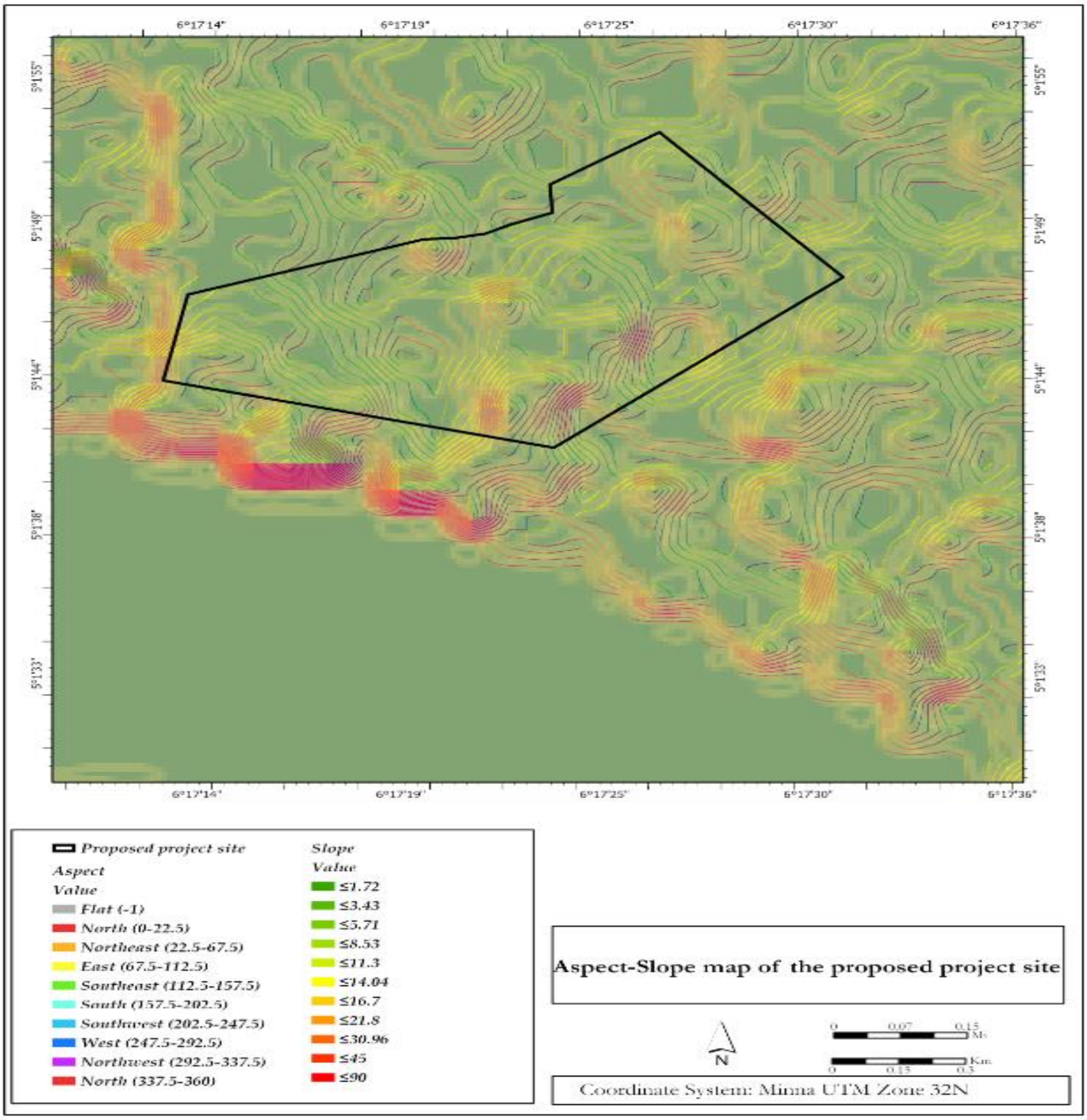

FIG 4.22: ASPECT-SLOPE MAP OF THE PROPOSED AREA
SOURCE: FIELD WORK

4.14 VEGETATION AND WILDLIFE

The vegetation of Bayelsa State like other Niger Delta, comprises four ecological logical zones. These include coastal barrier island forests, mangrove forests, freshwater swamp e.g. forests and lowland rain forests. These different or vegetation types are associated with the various soil units in the area, and they constitute part of the complex Niger Delta ecosystems. Parts of the freshwater swamp forests in the state constitute the home of several threatened and even endangered for plant and animal species. There are coastal barrier highland forests and mangrove forests. Coastal barrier highland forest vegetation is restricted to the narrow ridges along the coast. This vegetation belt is characterized by low salinity-tolerant freshwater plants

The assessment of the vegetation was done to identify the types of plants, crops, grasses that are found within the study area. This was done through visual inspection and observation along the project area. Inventory of plants species on the project area was taken at intervals. The characterization, identification and classification of the plant species and communities were undertaken both at the field and with reference materials. The ecological zone is made up of mixtures of trees, shrubs, herbs, grasses and food crops. The floristic composition is highly diverse in species even over a relatively homogenous area. It consists of typical southern Guinea Savannah genera with its herbaceous species and grasses.

The vegetation study focused more on the forest locations of the proposed project environment where, though human activities such as hunting and timbering activities were not all that heavy, but there was evidence of some relatively lightly disturbed habitats expected to still retain wildlife and are sites of gathering of bush mangoes (ogbono) and spices with modified fish pond activities. There was evidence of economically important non-timber plants of economic value and high floristic diversity. It was not within the scope of this study to carry out comprehensive study of vegetation by using transects or plot enumeration method, but to an extent to evaluate the general floristic diversity and collection of important plants of scientific interest. From this study, it is hoped that steps leading to conservation of important sites can be established soon in the area and at the same time, concerted study programme, involving scientific enumeration of plants and animals overtime, and ongoing collections of reference specimens will begin, with habitat assemblages identified, and collections of ethno-botanical knowledge will start.

The vegetation study also observed proposed project activity near the forested sites, to assess their extent acquisition, clearing method used, land preparation and facilities put in place e.g. walling of the site.

4.14.1 SURVEY PROCEDURE

The riverside vegetation was reached using outboard engine boat and the forest land was reached by trekking and wading round the bush on foot with guards from the village introduced to us who accompanied us as guides. General vegetation types were recorded, and samples of plants were collected for further identification. Question about community usage of forest, the amount of timbering and hunting in the area, where highlight while trekking through the forest. All plant samples collected were preserved and those that were not immediately identified were taken to the Forestry Research Institute for taxonomic identification.

4.14.2 FIELD OBSERVATIONS

The proposed project site had been walled round with blocks and gate entrance with few caravans aa site office. The road leading to the company site were surfaced and filled with limestone for easy driving of vehicles and both sides of the road were heavily farmed with cassava, cocoyam and plantain intercropped with banana and yam. The forest around the facility though degraded by past logging and hunting was observed to be a good example of a typical secondary raphia seasonal swamp forest undergoing regeneration and to harbor interesting diversity of vegetation, such as raphia species, symphoria globulifera, mitragyna species (abura), Irvingia gabonensis (ogbono). We even observed ogbono camps for seasonal gathering and processing of these important economic crops. Most of the plant species observed in the forest areas were of economic and medicinal value as shown below.

PLATE 4.15: HERBS AND SUGARCANE PLANT WITHIN POLAKU COMMUNITY

PLATE 4.16: VEGETATION AND FOOD CROPS WITHIN THE PROJECT SITE

PLATE 4.17: BANANA PLANT WITHIN POLAKU COMMUNITY

PLATE 4.18: GUAVA TREE WITHIN POLAKU COMMUNITY

PLATE 4.19: VEGETATION & FOOD CROPS WITHIN POLAKU COMMUNITY

TABLE 4.15: SOME COMMON ECONOMIC TREES/PLANTS IN THE STUDY AREA

S/N	Scientific Name	Family Name	Common Name	Economic Value
1	Dacryodes Edulis	-	Pearl	Edible fruits
2	Bambusa Vugaris	-	Bamboo	Craft work, stake for yams
3	Carica Papaya	-	Pawpaw	Fruits used as food
4	Mangifera indica	Anacardiaceae	Mango	Edible fruit, Medicinal
5	Citrus Aurantium	Rutaceae	Orange	Edible fruit
6	Elaeis Guineensis	Palmae	Oil palm	Edible, broom, sponge etc.
7	Pentachethra Macrophylla Benth	-	Oil Bean tree	Edible fruits and used wood fuel
8	Hevea brasiliensis		Rubber	Cash crop, export, manufacturing raw material
9	Pennisetum Purpureum	-	Elephant grass	Pasture
10	Cocos Nucifera	Palmae	Coconut	The fruits are edible, used for body oil
11	Imperata Cylindrica,	-	Spear grass	Pastural farming
12	Axonopus Affinis	-	Carpet Grass,	Pastural farming
13	Eupatorium Odorantum	Asteraceae	Siam Weed	Medicinal
14	Raphia Farinifera		Raffia Palms	Housing, drink etc
15	Sida Acuta	Malvaceae	Wireweed	Pastural farming

TABLE 4.16: LIST OF FOOD CROPS ENCOUNTERED IN THE STUDY AREAS

S/N	SCIENTIFIC NAMES	COMMON NAMES	ECONOMIC VALUE
1	Vernonia Amygdalina	Bitter leaf	Edible
2	Solanum Melongena	Garden egg	Edible fruits
3	Psidium Guajava	Guava	Edible
4	Xanthosoma Sagittifolium	Cocoyam	Edible
5	Magnifera Indica	Mango	Edible
6	Musa Parasidiaca	Plantain	Edible
7	Cola Nitida	Kola	Edible, drug and stimulant
8	Saccharun Officinarum	Sugar cane	Edible
9	Elaeis Guinensis	Oil Palm	Edible, soap production
10	Zea Mays	Maize	Edible cobs
11	Lycopersicon	Tomato	Edible vegetable

	esculentum		
12	Talinum Triangulare	Waterleaf	Edible
13	Saccharum Officinarum	Sugar cane	Edible
14	Musa Sapientum	Banana	Edible
15	Carica Papaya	Pawpaw	Edible
16	Manihot Esculenta	Cassava	Edible tubers, used in textile industry
17	Abelmuschus Esculentus	Okro	Edible fruits
18	Vernonina Amygdalina	Bitter Leaf	Edible and medicinal
19	Citrullus lanatus	Melon	Edible
20	Corchorus Olitorius	Jute Mallow or bush okra	Edible vegetable
21	Orange	Citrus X sinensis	Edible
22	Citrus aurantiifolia	Lime Orange	Edible
23	Ipomoea batatas	Sweet Potato	Edible
23	Capsicum	Pepper	Edible

4.15 AQUATIC STUDIES/HYDROBIOLOGY

Aquatic and wetland ecosystems have a broad array of structural properties and functions that are essential for the indirect and direct support of mankind. Water quality is a key factor to both natural and societal uses of water. Healthy aquatic ecosystems can assimilate and purify low levels of pollution, resulting in drinkable and swimmable conditions. Water quality is also very essential to the protection of the aquatic resources upon which humans indirectly depend, such as fish and shellfish as food resources and as support of healthy natural food webs that support the birds and other wildlife we appreciate for their aesthetic qualities. Water quality protection is also of great importance for protecting waters used for agricultural activities and for drinking water. The natural exchange between surface water and groundwater supplies create a link that calls for a holistic approach to aquatic ecosystem assessment and management. Aquatic systems such as lakes, ponds, and wetlands also provide important hydrological support for anthropogenic activities through their roles in water conveyance and storage.

There are sources of natural water (Taylor Creek & Nun River) bordering the study area. The Taylor creek is a source of livelihood to the community as lot of fishing and other industrial activities take place along the creek such as the Shell Gas-Gbarain and the Kolo Power Station.

PLATE 4.20: TAYLOR CREEK ALONG THE PROJECT CORRIDOR AND EQUIPMENT FOR HYDROBIOLOGY

PLATE 4.21: TAYLOR CREEK ALONG THE PROJECT CORRIDOR AND EQUIPMENT FOR HYDROBIOLOGY

PLATE 4.22: AN AQUACTIC ECOLOGIST CONDUCTING SAMPLING ON TAYLOR CREEK

4.15.1 FLOOD VULNERABILITY

Flood is one of the most disturbing, frequent, and widespread of all environmental hazards and of various types and magnitudes in recent times. Though, an environmental challenge as it appears, it is an inevitable natural phenomenon which occurs from time to time in all rivers and natural drainage systems, which not only damages the lives, natural resources and environment, but also causes loss of economy and health year after year. Floods can be defined as a large quantity of water covering a dry land. It occurs when water temporarily covers an area that it usually does not due to excess rainfalls than the soil and vegetation can absorb. The excess water runs off the land in greater quantities than rivers, streams, ponds and wetlands can contain. Heavy rains of such nature periodically cause rivers to overflow their banks, spilling onto the surrounding floodplains. Flood is a naturally occurring event that is dependent not only on rainfall amounts, but also on the topography of the area, and antecedent moisture conditions. It has displaced people, claimed lives and destroyed properties.

Floods are generally classified as fluvial (Riverine), pluvial (Ponding), flash, coastal and urban floods. Fluvial floods are as a result of water from rivers when the rivers' banks overflow usually as a result of excessive rainfall. Pluvial floods on the hand, occurs when there is excessive rainfall such that the natural drainage systems are saturated and unable to discharge water. Flash floods occur when water rises suddenly to unsafe levels in a rapid manner with little or no advance warning. It usually results from intense rainfall over a relatively small area. Permeable soil layers are been replaced by impermeable paved surfaces, through which water cannot infiltrate leading to generation of greater runoffs, causing rivers, roadways and parks to flood. Simply, coastal flood is when the coast (i.e. a water touching land strip) is flooded by the sea. The sea can overflow or overtop flood defences such as sea walls, perhaps due to a heavy storm (storm surge), a high tide, a tsunami or a combination thereof. Bayelsa State is seen as one of the most susceptible states in Nigeria to flooding due to its location in the heart of the Niger Delta. Flood arising from annual coastal rising waters has been plaguing most communities in the state and the Niger Delta even before the era of climate change awareness. Recent flood disasters in Bayelsa State and Nigeria at large, has claimed many lives and properties, and threatened the ecological biodiversity. Bayelsa State annually experiences flood occasioned by climate change that triggers devastating losses in human lives, economic assets, school attendance with multiplier consequences for the education system.

The project location is low land and it experiences flash flood arising from rainfall.

PLATE 4.23: FLOOD AREA WITHIN PROJECT LOCATION

PLATE 4.24: FLOOD AREA WITHIN PROJECT LOCATION

4.15.2 METHODOLOGY OF HYDROBIOLOGY

Benthic macrofauna samples were collected using Eckman's grab, the samples were sieved immediately after retrieval from water and the grab contents emptied into the sieving bag and screened through a 0.5mm mesh sieve using water. The sediment and faunal materials retained by the sieve were transferred to a sealed plastic container, labelled, and preserved in 10% buffered formalin solution and transported to the laboratory. In the lab, the samples were emptied into white tray and sorted. All the animals in the sorted samples were preserved with 75% ethanol in vial containers. These were identified to the lowest possible taxonomic levels under the stereo microscope and individuals of each taxonomic group were counted and recorded.

4.15.2.1 BENTHOS RESULTS

Benthic study was conducted for macro-fauna assemblages from the four (4) sampled points which consisted of various forms of aquatic organisms. The organisms are classified into 4 major taxonomic groups such as Oligochaeta, Insecta, Crustacea and Gastropoda. The results are presented on **Table 4.17.**

The Oligochaeta had the highest number of species and population of individual organisms. The group was represented by four (4) species with total number of 50 organisms (47.2%) of the total stock of benthic organisms recorded during the study, followed by insect with 2 species and a total of 22 organisms (20.8%), the Crustacea also with 2 species contributed 20 organisms constituting 18.9% and the Gastropoda with only one specie contributed 13.2% was least on the table.

Species distribution of organisms along the station had an even distribution but numerical strength of individual organisms varied between stations. Station one had the highest number of organisms with 109 (21.4%) while station two with 79 individuals contributed 15.5% of the total stock of benthos. Station 3 and 4 had equal number of organisms with 18.8% respectively. A total of 510 benthic organisms were harvested from the sediment samples during the study period. There was a short fall in population of both individual organisms as well as species composition in the area. This poor result was expected due to instability of sediment resulting from rainfall and water current causing sediment to erode and destabilizing sediment organisms.

TABLE 4.17: SPECIES COMPOSITION & NUMBER OF OCCURRENCE OF BENTHIC ORGANISMS ALONG THE SAMPLING POINTS.

	TAXONOMIC GROUPS	Study Stations					
		SW 1	SW 2	SW 3	SW 4-control Sample	TOTAL	%
	OLIGOCHAETA						
	Naididae						
1.	Dero sp.	3	1	2	2	8	
2.	Chaetogasta diaphanus	4	2	2	1	9	
3.	Ophidonais serpentina	8	4	2	3	17	
4.	Uncinais uncinata	4	1	1	0	6	
5.	Paranais sp.	6	3	1	0	10	
	Total	**25**	**11**	**8**	**6**	**50**	**47.2%**

	INSECTA						
1.	Chironomidae:						
2.	Chironomus ablabiesmia	5	7	2	0	14	
3.	Tanipus sp.	2	4	1	1	8	
	Total	**7**	**11**	**3**	**1**	**22**	**20.8%**
	CRUSTACEA						
1.	Penacidae						
2.	Macrobrachion	2	4	1	3	10	
3.	volenhovenii	4	1	3	2	10	
	Macrobrachion	**6**	**5**	**4**	**5**	**20**	**18.9%**
	felicinum						
	Total						
	GASTROPODA						
1.	Viviparidae						
2.	Viviparous unicolor	**6**	**3**	**5**	**0**	**14**	**13.9%**
	Total No: Individuals	**44**	**30**	**20**	**12**	**106**	
	Percentage	**41.5%**	**28.3%**	**18.9%**	**11.3%**		

4.15.3 PHYTOPLANKTON

These are the organisms that occupy the lowest tropic level which other life depend directly or indirectly on as a primary food source. Phytoplankton samples were collected using plankton net tow on a boat moving along the river. After each tow, the samples were emptied into vial container and preserved with 5% formalin stained with eosin. These were transported to the laboratory for analyses. In the lab, the samples were allowed to stand for 24 hours. Pipette dropper was used to collect preserved sample, 1 ml concentrated sample was properly homogenized and transferred into a sedge wick Rafter counting chamber using sample pipette. The organisms were identified and enumerated under a binocular microscope (140 – 144x).

The phytoplanktons are the primary producers of the food web. They form the bases of which other lives depend upon for food and nutrients, without them life will not be complete and therefore are regarded as the most important group of organisms in life.

The phytoplanktons are made up of Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae as recorded during the baseline studies in the area. The Bacillariophyceae had 17 species distributed across the various sampled stations, the total number of organisms were 274 individuals contributing about 53.7% of the total phytoplankton stock harvested during the study period were rated highest amongst the groups followed by Chlorophyceae with 32.7%. Euglena was the lowest contributing 4.1%.

The distribution of individual organisms varied along the different stations such that the population of individual stock of organism ranged between 79 organisms (15.5%) and 109 (21.4%) across the stations. The highest number of organisms 109 was recorded in station 1 while the lowest was observed in station 2. A total of 510 organisms were realized from the entire 4 stations joint together. The reason of the low abundance had been stated above in benthos and zooplankton results.

TABLE 4.18: PHYTOPLANKTON SPECIES COMPOSITION AND NUMERICAL STRENGTH IN DIFFERENT STATIONS.

	TAXONOMIC GROUPS	**Study Stations**					
		SW1	**SW2**	**SW3**	**SW4-CONTROL SAMPLE**	**TOTAL**	**%**
	CHLOROPHYDAE						
1.	Closterium acerosum	8	4	13	2		
2.	Closterium	5	15	9	5		
3.	closteroides	2	0	1	3		
4.	Closterium gracile	6	3	3	4		
5.	Closterium lunata	10	8	8	2		
6.	Spirogyra cumminis	5	1	4	2		
7.	Spirogyra dubia	3	3	0	8		
	Ulothrix tennuisima	**39**	**34**	**38**	**26**	**167**	**32.7%**
	Total						
	BACILLARIOPHYCEAE						
1.	Amphora sp.	5	1	3	6		
2.	Aulococeira	2	4	0	3		
3.	granulate	3	1	6	4		
4.	Melosira	7	6	2	1		
5.	nummuloides	2	3	7	3		
6.	Cymbella sp.	4	1	6	1		
7.	Eunotia gilbbossa	1	0	1	5		
8.	Eunotia	0	2	2	4		
9.	astosionelloides	1	1	5	2		
10.	Eunotia sp.	5	0	0	3		
11.	Fragillaria	3	1	0	0		
12.	**constuents**	6	3	1	5		
13.	Gyrosigma	4	0	0	2		
14.	scalproides	1	5	1	3		
15.	Gomphonema sp.	3	2	4	1		
16.	Navicula pusila	2	0	1	0		
17.	Navicula lanceolata	4	1	3	5		
	Nitzschia accicularis	**53**	**31**	**42**	**48**	**274**	**53.7%**

	Pinularis inflate Pinularis sublinearis Snedra acus Tabellaria fenestriata **Total**						
 1. 2. 3. 4.	**CYANOPHYCEAE** Anabaena flos-aqua Oscillatoria bornettia Oscillatoria princeps Oscillatoria formosa **Total**	 2 4 8 2 **16**	 3 1 1 6 **11**	 6 1 0 0 **7**	 3 1 1 6 **11**	**45**	**8.0%**
 1. 2. 3.	**EUGLENOPHYCEAE** Euglena acus Euglena oblongata Euglena caudata **Total**	 1 0 0 **1**	 0 1 2 **3**	 5 2 2 **9**	 1 6 4 **11**	**24**	**4.1%**
	Total No of Individuals	**109**	**79**	**96**	**96**	**510**	
	Percentage	**21.4%**	**15.5**	**18.8%**	**18.8%**		

4.15.4 ZOOPLANKTON

These are organisms made of the juvenile and larval stages of larger animals such as zoea, shrimps zoea, fish larva/embryo, vegiller of larvae of molluscs, and permanent zooplankton, such as copepods, insects, annelids, etc. The zooplankton sampling was carried out with the aim of identifying the various taxonomic groups of zooplankters. The various taxas chosen at the station were enumerated, with which an index or their abundance in relationship to the level of pollutants could be established. The method follows that subsurface water were towed through plankton net for some minutes and the organisms retained in the net were emptied into vial containers and preserved just the same way and manner as that of phytoplankton and analysed the same way. Following a thorough agitation and homogenization, 1ml sub-samples were taken using a sample pipette and transferred to a graduated 1ml counting chamber for observation under a microscope with magnification of 40 to 400x. The organisms were simultaneously identified and enumerated, and results entered on analysis sheets.

The major taxonomic groups encountered includes Cladocera with 6 species and a total of 143 individual organisms (43.7%) of the total zooplankton stock, Copepoda was second with 95 organisms (29.1%), Protozoa 57 individuals (17.4%) and Decapoda with 2 species had 32 individual organisms (9.8%). The Zooplankton which are the primary consumers depends on the abundance of phytoplankton for food, while the abundance and composition of phytoplankton is a function of available nutrient in an ecosystem, season and other environmental factors.

Along the stations, the population of organisms ranged between 70 (21.4%) and 94 organisms (28.7%) out of the 327 organisms recorded in the area. Station 2 and station 3 were least in abundance while station 4 had highest number of individuals on the table.

TABLE 4.19: SPECIES COMPOSITION AND NUMBER OF OCCURRENCE OF ZOOPLANKTON ALONG THE SAMPLING POINTS.

	TAXONOMIC GROUPS	Study Stations					
		SW1	SW2	SW3	SW4-Control Sample	TOTAL	%
	CLADOCERA						
1.	Daphnia pulex	8	12	6	4	30	
2.	Daphnia carinata	13	7	3	10	33	
3.	Bosmina fartalis	7	3	5	5	20	
4.	Bosmina longirostris	14	5	4	8	31	
5.	Macrothrix rosea	2	1	1	3	7	
6.	Moina dubia	6	2	6	8	22	
	Total	**50**	**30**	**25**	**38**	**143**	**43.7%**
	COPEPODA						
1.	Paracyclops fimbriata	9	6	2	7	24	
2.	Paracyclops affinis	6	3	17	5	31	
3.	Microcyclops albridus	1	5	2	9	17	
4.	Onchocampus Mohamed	3	3	1	4	11	
5.	Calanus fimmaculatus	4	1	1	6	12	
	Total	**23**	**18**	**23**	**31**	**95**	**29.1%**
	DECAPODA						
1.	Macrobrachion	3	6	3	1	13	
2.	volenhovenii	7	2	4	6	19	
	Macrobrachion felicinum	**10**	**8**	**7**	**7**	**32**	**9.8%**
	Total						
	PROTOZOA						
1.	Frontonia leucas	3	4	6	9	22	
2.	Euglypha ciliata	1	2	1	2	6	
3.	Ulotrichia forcita	4	7	5	6	22	
4.	Centrophyxis constrida	2	1	3	1	7	
	Total	**10**	**14**	**15**	**18**	**57**	**17.4%**
	Total No: Individuals	**93**	**70**	**70**	**94**	**327**	
	Percentage	**28.4%**	**21.4%**	**21.4%**	**28.7%**		

4.16 FISH AND FISHERIES

Fishing is the major traditional occupation of the people in Polaku town. This is carried out in the surrounding Taylor creek and Nun River close to the community. There were no commercial fishers, artisanal fishers or small-scale fishers dominate the fishery of the area. They operate in dug-out wooden canoes, plank wooden canoes which may or may not be motorized. Fishing gear were largely made of manually operated traps, cast net, long setlines, circling nets and seine nets, gill nets, drift nets of different mesh sizes varying from ½", 1", 1½", 2", 2½ to 3" and 3 to 4". The fishing gear measure 6-80m in length and 3-6 meters in width. Usually the nets are set and allowed to stay for up to one hour before they are removed with the catch. In case of traps, they are allowed to stay for 24 hours, 48 hours and even above 72 hours before hauling. When the net is set and before it is removed another net is also set. Catch rates are seasonally dependent and varied between 15 and 120 kg/day in the wet season. Income from fishing activities in the area is on the average of ₦30,000 - ₦40,000 per month. Fin fishes identified are mainly freshwater fish species because it is surrounded by freshwater. Shell fish in this area include the shrimps (e.g. Macrobrachium spp.).

4.16.2 COMPOSITION OF FISH SPECIES

The families and fish species identified from catches of artisanal fishers in the study area (Polaku Town) are presented in Table 4.20. A total of 50 fish species belonging to 20 families were identified during the study period. Out of which, 47 of them are fin fish comprising of the family Mochokidae with 7 species (Synodontis clarias, Synodontis membranaceous, Synodontis sorex, Synodontis ocellifer, Synodontis nigrita, Synodontis schall and Synodontis melanopterus), Mormyridae with 4 species (Mormyrus rume, Hyperopisus bebe, Mormyrops deliciosus and Mormyrus deboensis). Other families are Alestidae with 5 species (Brycinus nurse, Alestes baremose, Hydrocynus brevis, Hydrocynus forskalii and Alestes dentex), Clariidae 2 species (Heterobranchus bidorsalis, Heterobranchus longifilis), Bagridae 3 species (Bagrus filamentosus, Bagrus bayad, Bagrus docmac), Claroteidae 3 species (Chrysichythys nigrodigitatus, Clarotes laticeps and Chrysichthys auratus), Distichodontidae with 2 species (Distichodus rostratus and Distichodus engycephalus), Cichlidae 3 species (Oreochromis niloticus, Tilapia zilli and Hemichromis fasciatus, Malapteruridae 1 species (Malapterurus electricus), Latidae 1 species (Lates niloticus), Citharinidae 3 species (Citharinus citharus, Citharinus latus and Citharinus thomasi), Cyprinidae 2 species (Labeo coubie and Labeo senegalensis), Notopteridae 1 species (Polypterus senegalus), Arapaimidae 1 species (Heterotis niloticus), Eleoteridae 1 species (Eleotris senegalensis), Gymnarchidae 1 species (Gymnarchus niloticus), Hepsetidae 1 species (Hepsetus odoe) and

Schilbeidae 3 species (Schilbe intermedius, Schilbe mystus and Schilbe isidori) while 3 of the fish species are fin fish from the family Paleomonidae with 3 species (Macrobrachium felicinum, Macrobrachium vollenhovenii and Macrobrachium macrobrachion). The dominant fin fish species were Chrysichthys nigrodigitatus, Distichodus rostratus, Bagrus bayad, Synodontis sorex and Mormyrus rume while the shell fish was dominated by Macrobrachium felicinum, Macrobrachium vollenhovenii and Macrobrachium macrobrachion. The health status of the fishes was satisfactory and the specimens were of medium size and showed no evidence of pathological deformities. The shellfish species was dominated by Macrobrachium felicinum while the fin fish was dominated by Chrysichthys nigrodigitatus. The fin and shell fishes from the area are presented below on Plate 4.25A-4.25K showing photographs of some fish species caught by fishers in Polaku Town. Generally, there was more fish during the wet season compared to the dry season. However, information gathered from fishers and literature revealed a rich assemblage of ichthyofauna especially in this axis of the Taylor Creek and Nun River where Polaku town is situated.

PLATE 4.25 A: SYNODONTIS SPP.

PLATE 4.25B: HETEROBRANCHUS BIDORSALIS

PLATE 4.25C: CLAROTES LATICEPS

PLATE 4.25D: CHRYSICHTHYS NIGRODIGITATUS

PLATE 4.25E: CLARIAS GARIEPINUS

PLATE 4.25F: POLYPTERUS SENEGALUS

PLATE 4.25G: HYPEROPISUS BEBE

PLATE 4.25H: MORMYRUS ANGUILLOIDES

PLATE 4.25I: LABEO COUBIE

PLATE4.25J: MALAPTERURUS ELECTRICUS

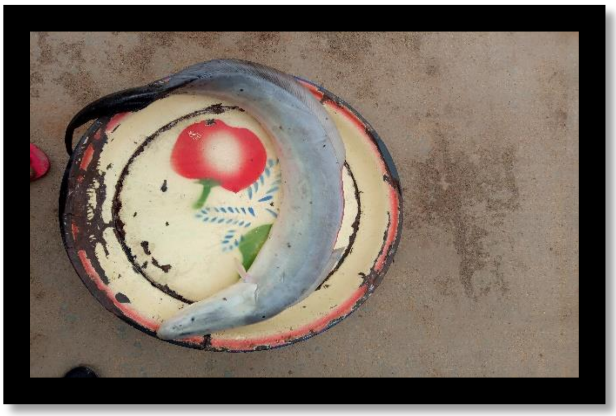

PLATE 4.25K: GYMNARCHUS NILOTICUS

TABLE 4.20: LIST OF SOME FAMILIES AND SPECIES OF FISH IDENTIFIED IN THE STUDY AREA (POLAKU TOWN)

Fin Fish		
Family	**Scientific Name of Species**	**English/Common Name**
Alestidae	Brycinus nurse	Nurse Tetra
	Alestes baremose	Silversides
	Hydrocynus brevis	Tiger fish
	Hydrocynus forskalii	Tiger fish
	Alestes dentex	Characin
Arapaimidae	Heterotis niloticus	African Bonytonge
Eleoteridae	Eleotris senegalensis	Sleeping Gobies
Bagridae	Bagrus filamentosus	Catfish
	Bagrus bayad	Catfish
	Bagrus docmac	Catfish
Cichlidae	Oreochromis niloticus	Nile Tilapia
	Tilapia zilli	Tilapia
	Hemichromis fasciatus	Tilapia
Citharinidae	Citharinus citharus	Moon fish
	Citharinus latus	Moon fish
	Citharinus thomasi	Moon fish

Clariidae	Heterobranchus bidorsalis	Catfish
	Heterobranchus longifilis	Catfish
	Clarias anguillaris	Catfish
	Clarias gariepinus	Catfish
Claroteidae	Chrysichthys nigrodigitatus	Silver Catfish
	Clarotes laticeps	Wide-head Catfish
	Chrysichthys auratus	Silver Catfish
Cyprinidae	Labeo senegalensis	
	Labeo coubie	African Carp
Distichodontidae	Distichodus rostratus	Grass-eater
	Distichodus engycephalus	Grass-eater
Gymnarchidae	Gymnarchus niloticus	Trunk Fish
Hepsetidae	Hepsetus odoe	African Pike
Latidae	Lates niloticus	Nile Perch
Malapteruridae	Malapterurus electricus	Electric Catfish
Mochokidae	Synodontis clarias	Catfish
	Synodontis membranaceous	Catfish
	Synodontis sorex	Catfish
	Synodontis ocellifer	Squeaker Catfish
	Synodontis nigrita	Squeaker Catfish
	Synodontis schall	Catfish
	Synodontis melanopterus	Squeaker Catfish
Mormyridae	Mormyrus rume	Mormyrids
	Hyperopisus bebe	Mormyrids
	Mormyrus deliciousus	Mormyrids
	Marcusenius deboensis	Mormyrids
Notopteridae	Papyrocranus afer	Knife-Fish
Polypteridae	Polypterus senegalus	Gray Bichir
Schilbeidae	Schilbe mystus	Butter Catfish
	Shilbe isidori	Butter Catfish
	Schilbe intermedius	Silver Catfish

TABLE 4.21: LIST OF THE FAMILY AND SPECIES OF SHELLFISH IDENTIFIED IN THE STUDY AREA THE STUDY

ShellFish

Family name	Scientific Name of Species	English/Common Name
Paleomonidae	Macrobrachium felicinum	Shrimp
	Macrobrachium vollenhovenii	Shrimp
	Macrobrachium macrobrachion	Shrimp

4.16.3 TYPES OF FISHING GEARS WITHIN POLAKU COMMUNITY

There are various types of artisanal fishing gear (i.e. instruments or equipment or tools) used in capturing fish in Polaku Town. They include traps, hook and longline, nets such as cast nets, set nets, drift nets, gill nets, scoop nets as well as fish fence and spear. The plates below present photographs of some artisanal fishing gear commonly used in the study area.

PLATE 4.26A: BISENI (FUNNEL BASKET) TRAP

PLATE 4.26B: METAL DRUM (CYLINDRICAL METAL) TRAP

PLATE 4.26C: MALIAN (CONICAL BASKET) TRAP

PLATE 4.26D: IDERIBO (FUNNEL BASKET) TRAP

PLATE 4.26E: INGO (RECTANGULAR BASKET) TRAP

PLATE 4.26F: IKARA (RECTANGULAR BASKET) TRAP

PLATE 4.26G: HAND HOOK AND LINE

PLATE 4.26H: TWO CHAMBERS MALIAN (BASKET) TRAP

PLATE 4.26 I: CIRCULAR SCOOP NET

PLATE 4.26J: TWO CHAMBERS INGO (RECTANGULAR BASKET) TRAP

PLATE 4.26K: LONGLINE (MARI-MARI)

PLATE 4.26L: SET GILL-NET

PLATE 4.26M: GILL-NET (ELELIDII)

PLATE 4.26N: LONGLINE (SARADII)

PLATE 4.26O: SPEAR (OGBOROWEI)

PLATE 4.26P: CAST-NET (IGBO)

4.16.4 FISHERIES ACTIVITIES

Fisheries sub-sector is a significant source of fish food and livelihood for many people living in Polaku town as it supplies cheap source of animal protein necessary for growth and income for many households in the study area. These fisheries activities are very crucial because it helps in reducing poverty and enhancing food security. Fisheries activities carried out in this area include:

1. Fish processing,
2. Fish preservation
3. Fish sorting
4. Fish packaging
5. Fish storage
6. Fish marketing and distribution

4.16.4.1 FISHING METHODS

Fishing methods adopted by the people in the study area are:

1. Netting method
2. Trapping method
3. Angling method

4. Spearing method

4.16.4.2 SPAWNING GROUNDS

The spawning grounds for fishes in the study area are:

1. Floodplains
2. Stream (Okouba stream)
3. Nun River
4. Taylor Creek

4.16.5 MIGRATION ROUTES AND PATTERNS

Many species of fish in the study area wander annually through a particular area of the water bodies (Nun River and Taylor Creek) around Polaku town. Some are true migrants, travelling regularly over great distances. Young fish usually leave the spawning grounds for areas where they develop into juveniles, before joining the adult stock at the feeding grounds. Adults move to the spawning grounds, then return to the feeding grounds. Migratory patterns of fish are related to oceanographic factors and to current, eggs, larvae and young drift passively with the current, although migration of adult's fish toward breeding grounds is usually against the current. Adults movement thus are directional rather than passive, and the fish respond to environmental conditions e.g. climate.

4.16.6 FISH PATHOLOGY

Disease management is primary requirement in fish production both in nature and artificial conditions. In natural condition, parasites and pathogens are natural strategy in maintaining, viral population, enhancing genetic quality vitality and viability for the survival of fittest. It ensures good succession and health future survival in maintaining the fish species. Under artificial conditions, is a sign of stress due to poor or inadequate management of the entire system, hygiene water quality, feeding and in general poor husbandry (aquacultural) practices, thus poor and low immunity and so the outcome of disease syndromes. Some common parasites and pathogens that affects fish in the study area include: Helminths and crustaceans such as Nematoes, Cestodes, Neascus, Mites, Monogenias, Crustaceans and Protozoas such as Henneguyas, Myxosporas, Trypanosomas, Trichodinas and Chilodenella.

4.17 SEDIMENT

Environmental degradation & pollution is a major concern globally and it requires concerted effort. This is due to anthropogenic activities in the area of urbanization, industrialization and population growth. Pollution of environmental components (soil, water and air) is on the increase in many developing nations. The air pollutants are mainly in the form of odour, noxious gases and air particulates. When aerosols are formed, air particulates have the tendency to be deposited in the soil and surface water systems. The soil plays essential role for living organisms as well as human. As such, most human activities are carried out on land. Human activities on soil have direct or indirect effect on soil quality. The soil receives many waste streams emanating from several anthropogenic activities such as industrial and domestic activities. The soil also receives poorly managed wastes resulting from human activities.

During rain fall, most wastes end up in the aquatic ecosystem via runoff. The severity of poor waste management practices often deteriorates the potability of surface water system within the proximity of communities in the coastal region of the Niger Delta. Surface water impacted by several human activities often lead to contamination. The pollution of surface water does not only affect its suitability for domestic use and public consumption but it also affects the sediment quality as well as distribution and abundance of aquatic organisms including macrophytes, planktons (zooplankton and phytoplankton), benthic micro and macro invertebrates, and fishes. Many aquatic organisms have been widely reported as indicator organisms. Fishes and planktons have been widely used to detect the presence or absence of toxicants in the aquatic ecosystem.

Bottom sediments are highly valuable as they provide useful information about the quality of aquatic ecosystems. As such, the ability of living organisms to survive in aquatic ecosystems depends on the water and sediment quality. Due to their nature, both organic and inorganic materials found embedded in the aquatic ecosystem as sediments. They are distributed as fine materials as clay, silt, and sand with diameter <2 mm); coarse materials (such as gravel, bedrock), (inorganics) and decomposable materials (such as animal matter, aquatic plants, etc), (organics).

In line with FMENV directive four sediment samples were collected from the Taylor Creek using the grab sampler.

PLATE 4.27: SEDIMENT SAMPLER (GRAB)

PLATE 4.28: CONSULTANTS CONDUCTING SEDIMENT SAMPLING IN TAYLOR CREEK

PHYSICOCHEMICAL PROPERTIES OF SEDIMENTS

The physicochemical characteristics of sediment samples collected from Taylor Creek at four (4) locations are shown on **Table4.22** below. The study is a one-season data gathering which was during the wet season. The laboratory reports are shown below. The mean pH value was 5.5, the mean values of Nitrate was 0.58mg/kg, while the mean value for chloride content was 4.5mg/kg.

TABLE 4.22: PHYSICOCHEMICAL PROPERTIES OF SEDIMENTS

S/N	Sample ID	PH APHA 4500H	Temp ^{O}C	Chloride ASTM D512 mg/l	SO_4 APHA 4500 mg/kg	NO_3 APHA 4500 mg/kg	NO_2 APHA 4500 mg/kg	NH_4 APHA mg/kg	N mg/kg
1	SED 1	5.5	24.6	3.9	2	0.6	0.07	0.4	1.0
2	SED 2	5.2	24.9	4.2	1	0.4	0.01	0.4	0.9
3	SED 3	5.6	24.8	3.6	3	0.6	0.08	0.5	1.2

S/N	Sample ID	PH APHA 4500H	Temp ^{O}C	Chloride ASTM D512 mg/l	SO_4 APHA 4500 mg/kg	NO_3 APHA 4500 mg/kg	NO_2 APHA 4500 mg/kg	NH_4 APHA mg/kg	N mg/kg
4	SED 4	5.5	24.3	6.4	3	0.7	0.08	0.4	0.9

CHARACTERISTICS OF SEDIMENT MICROBIOLOGY

From the laboratory analysis results of the sediment samples, the total heterotrophic bacterial count (cfu/g) of the sediment ranged from $2.10X10^6$ – $2.27X10^6$. The values of HUB ranged from $2.10X10^5$-$6.60X10^5$ while THF values ranged from$1.86X10^5$-$2.73X10^5$ and HUF values ranged from $1.80X10^5$ - $2.80X10^5$.

TABLE 4.23: MICROBIOLOGICAL PROPERTIES OF SEDIMENTS

S/N	Sample ID	THB Cfu/ml	HUB Cfu/ml	THF Cfu/ml	HUF Cfu/ml	T.Coliform (MPN/100 ml)	F.Coli (MPN/100 ml)
1	SED 1	$2.10X10^6$	4.30X105	$2.73X10^5$	$2.20X10^5$	N/A	N/A
2	SED 2	$2.32X10^6$	2.10X105	$2.64X10^5$	$1.80X10^5$	N/A	N/A
3	SED 3	$2.27X10^6$	6.60X105	$1.86X10^5$	$2.80X10^5$	N/A	N/A
4	SED 4	$2.17X10^6$	4.90X105	$2.15X10^5$	$2.10X10^5$	N/A	N/A

4.18 SOCIO-ECONOMICS

During the Environmental studies, the socio-economic data gathered comprises historical information, cultural norms, land tenure and land use pattern, population and demographic characteristics, health, morbidity, mortality, and fertility, occupations and income distribution, health social and other infrastructure. The Local Government Area in Bayelsa State as the Local Government Area hosting the project has one of the largest crude oil and natural gas deposits in Nigeria. As a result, petroleum production is extensive in the state. However, the majority of Bayelsans live in poverty. They are mainly rural dwellers due to the terrain and lack of adequate transportation, health, education or other infrastructure. This has been a large problem in the state since its creation; successive state governments have not been able to address and repair the issue. The Polaku community does not have industries or company operating in the community as compared to other neighbouring communities, a reason why the community embraced the proposed project. This will greatly improve their economic well-being. The local population engage in fishing on a subsistence and commercial level. The Bayelsa State government is otherwise the main employer in the state. Agriculture & fishing are sources of livelihood for most of the residents. It has favourable climate and rich fertile soil, for peoples' potentials to practice agriculture activities. The major

Agricultural products are cassava, maize, pepper, sugar cane, vegetables, yam, banana, plantain etc. Most of the farmers are peasants.

4.18.1 SOCIAL INFRASTRUCTURE OF THE STUDY AREA

A) WATER SUPPLY

There is no municipal water supply to the area; the residents mainly depend on borehole, rain and river water supply. The boreholes are provided by individuals within the community. The ones provided by SPDC are no longer functioning.

PLATE 4.29 A: BOREHOLE SOURCE OF WATER IN POLAKU COMMUNITY

PLATE 4.29B: BOREHOLE SOURCE OF WATER IN POLAKU COMMUNITY

PLATE 4.29C: WATER TANK INSTALLED TO COLLECT RAIN IN POLAKU COMMUNITY

B) ROAD NETWORK

The road networks are mainly tarred roads, concrete and earth (untarred roads) within the host community. There is a tarred road to the proposed project location and some road network within the Local Government area where the project is located. Majority of the roads are concrete that transverse the community streets.

PLATE 4.30A: EARTH ROAD WITHIN THE COMMUNITY

PLATE 4.30B:PAVED ROAD TO PROJECT LOCATION

PLATE 4.30C: TARRED ROAD TO THE COMMUNITY

PLATE 4.30D: ROAD AT PROJECT SITE & TO THE COMMUNITY

c) ELECTRICITY

The area under study has power supply from the National Grid. Southern ljaw and Yenagoa are provided with light by a state-run gas turbine.

PLATE 4.31: ELECTRICITY POLES WITHIN THE COMMUNITY

D) TRANSPORTATION

The major modes of transport in the state are waterways and roads. The state has many transport problems that have hindered its economic development for many years. The State, like any other state in the Niger Delta, is traversed by a network of River Niger's distributaries, resulting in widespread swamp land. Water transport is therefore the main means of movement. Speed boat is the characteristic mode of transportation. The efficiency and capacity of speed boats is poor because they do not normally carry goods and they accommodate fewer passengers than out-board engine boats. The slowest means of travel is the out-board engine boat, while the in-board engine boat usually has the largest capacity. Water transport in Bayelsa State is confronted with such problems as slowness, lack of safety, irregularity, lack of comfort, low efficiency and capacity, among others. The popular Taylor Creek serves as a means for water transportation in the project area.

PLATE 4.32: BOATS WITHIN POLAKU COMMUNITY USED FOR FERRIES & FISHING

E) ETHNIC DISTRIBUTION/CULTURE/RELIGION

Bayelsa State is dominated by the ljaw ethnic group whose members speak ljaw language. Other ljaw dialects include Tamu, Mein, Jobu, Oyariri, and Tarakiri. There are other pockets of ethnic groups such as Urhobo and Isoko. There are local dialects in some places. Other notable languages in the State are Epie, Atisa, Nembe and Ogbia. Christianity and traditional religion are the two main religions in the State. The culture of the people is expressed in their unique dresses, festivals, dietary habits, arts and crafts, folklore and dancing. These distinguish the people from other ethnic groups. The major crafts include canoe building, fish net and fish traps making, pottery, basket and mat making. Cane furniture industry is thriving in the project area and the State.

F). POLITICAL

The State Government is led by a democratically-elected executive Governor who worked closely with an elected State House Assembly. The State has great Political personalities such as the immediate past President of the Federation, Former Ministers of Petroleum Resources, Minister of State for Agriculture, Minister of State for Petroleum Resources, former Nigerian Minister of State for Energy and was Secretary General of the Organization of the Petroleum Exporting Countries etc. The State have great music artistes and footballers.

G). EDUCATION

The presence of scores of Secondary schools to absorb graduating primary school pupils in the Local Government Area, gave the opportunity of having both private and public teaching institutions. These included the Divine Comprehensive High School, Polaku, Excellent Child Development Centre, Confluence Town Primary

School, Community Secondary School, Government Craft Development Centre, God's Holiness Comprehensive High School, and Lord's Star Academy, Polaku.

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H) MARITAL STATUS

Marriage is an institution initiated by God Himself for procreation and if you are not married at the ripe age it shows some level of unseriousness. During the socio-economic survey, the percentage of married household respondents was higher than the singles within Polaku community. This figure portends to the fact that marriage is a significant societal institution in the area cherished and respected by all.

I) RELIGION

The religious background of the people within the project location is majorly Christianity, with some traditional worshippers. The traditional worshippers believe in the ability of deities to exercise strong influence on the destiny of man. Amongst the traditional activities is mainly the fishing festival held at Sabagreia. Some of the Churches identified within Polaku are the Redeemed Christian Church of God, Chapel of Faith, St Barnabas Anglican Church, Brotherhood of the Cross, etc.

J) TRADITIONAL INSTITUTIONS & POWER STUCTURE WITHIN THE COMMUNITY

The Polaku, Koroama, Ogbolama, Okolobiri and Obunagha communities comprise the Gbarain Kingdom in the Yenagoa Local Government Area of Bayelsa State. There are respective founders of each of these communities which make up the descendants of Gbarainowei (The founder of Gbarain kingdom). The language generally spoken is Izon as they are indigenous Ijaw (Izon) ethnic group. History has it that Polaku community was founded by Ebuyai-owei who was believed to have migrated from Okotiama. He gave birth to Ijewaribo and Iyewaribo, which has invariably developed into the present day Polaku Community where the proposed project is located. Polaku community comprises five quarters namely, the Opokuma-owei, Nebiegberegba, Ijewaribo, Yoropele and Iyewaribo.

There is a defined traditional hierarchy and line of authority within the proposed project area; this usually comprises the Clan Council of Chiefs headed by a Clan Head. There is a paramount ruler (Amananaowei) at the community level, with the responsibility of presiding over the affairs of community. The Amananaowei is elected by the community and seats in council with these other chiefs (compound chiefs, and councilors) to take decision on matters concerning the community. The Paramount Ruler is ably supported by the Council of Clan Chiefs, Elder Council, Clan Heads, Compound Chiefs, Community Development Committee (CDC), community youth leaders and women leaders. The current King in the Gbarain kingdom is HRM Funpere Gabriel Akah- Ibenanaowee of Gbarain Kingdom.

The identified traditional rites and festival and cultural heritage within the community are the marriage Rites, female circumcision, rites of inheritance. The traditional marriage is held with paramount importance that the bride price must be paid. The community have some rites like the rite of death of father and mother, death of male after 3days and female after 4days. Others are accidental death rite such as a death of pregnant women, death in an accident and death with wound on the body. There are rites that should be performed on all.

There are traditional festivals practiced within Polaku such as the UZU (New Yam festival, wrestling and chieftaincy Installation festival

K) POPULATION

The proposed project is located within the Yenagoa Local Government Area. According to the 2006 Population census, the population of Yenagoa was 352,285 comprising male (182,240) and female (170,045).

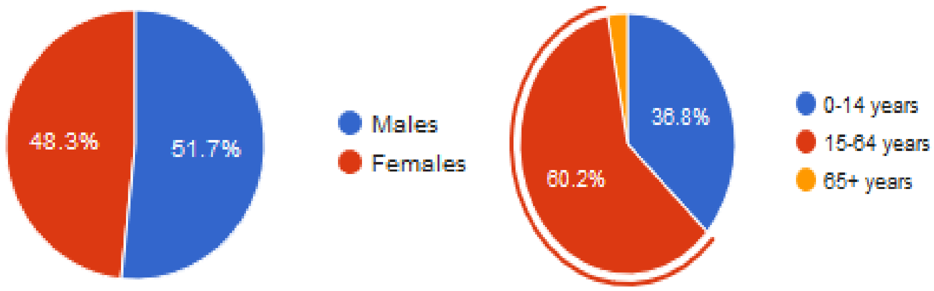


FIG 4.23: POPULATION DISTRIBUTION OF PROJECT LOCAL GOVERNMENT AREA

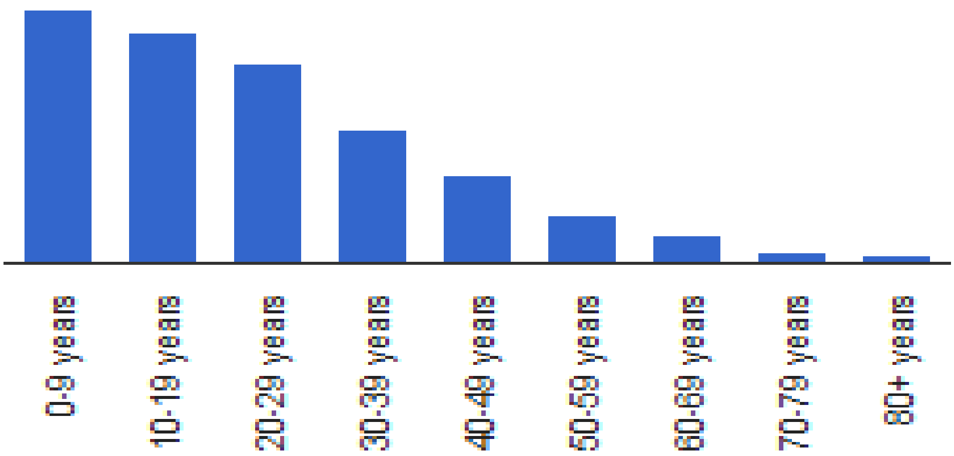


FIG 4.24: AGE DISTRIBUTION WITHIN THE PROJECT LGA
Source: CENSUS 2006

4.19 HEALTH STATUS

The field survey of the study area for the health data gathering was undertaken covering the Polaku community. There are health facilities within the project location such as the Niger Delta University Teaching Hospital to take care of the health needs of the community. During the field activities and interactions with inhabitants of these communities the following methods were deployed and the observations gathered are as stated below, viz:

- Oral interviews
- Physical observations
- Focus Group Discussions (FGD) held separately with adults, women and youths
- Socio-demographic data, with associated health impact
- Life style/Health behavioural practices
- Common health hazards in the communities
- Immunization status
- General health status.
- Health services/ community health needs
- Environmental/Public health
- Knowledge, attitudes and practices (KAPs)

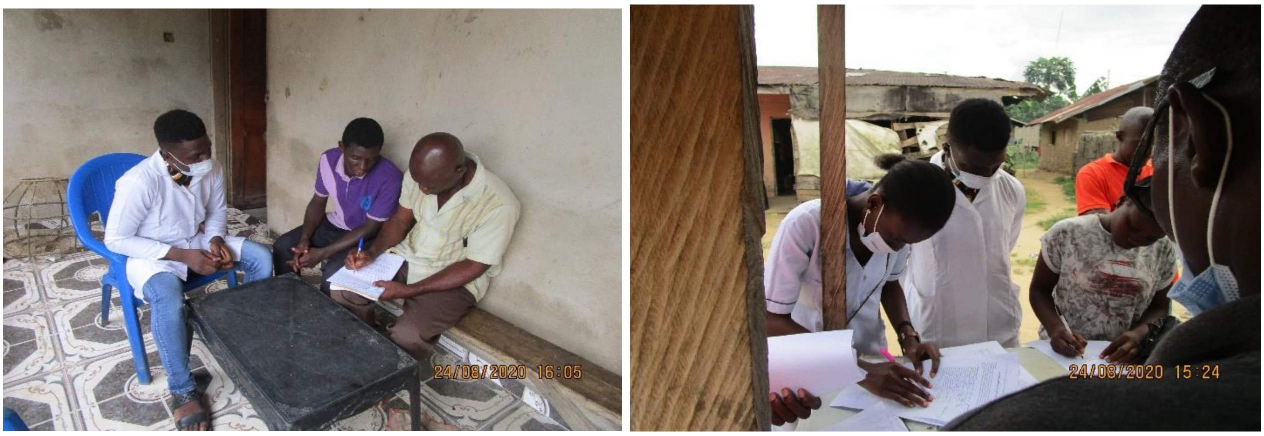


PLATE 4.33: HEALTH TEAM CONDUCTING HEALTH SURVEILLANCE

4.18.1 HEALTH ASSESSMENT METHODOLOGY

The environment under study was visited by the study teams for consultation during which the elders, youth leaders and women leaders were briefed on the aim and objectives of the study. Questionnaires were distributed to the opinion leaders within the community and meetings were held to gather information. Well-structured questionnaires were applied in the community and this represents 5% of the adult populations. The questionnaires, which addressed some health issues, were randomly applied to ensure that the entire community is covered.

Adult and children of both sexes from the community were physically examined for disease symptoms. Focus group discussions were held separately with representatives and groups in the community and issues on health were discussed using the approved questionnaires for focus group discussing (FGD). The environmental health determinants were studied by walking through the community and observing all health facilities and the environmental factors that contribute to ill health e.g. water, toilet types, projects, light, housing and waste disposal practices. These assessments were done using the approved questionnaires on HIA environmental health studies.

4.18.2 HEALTH IMPACT ASSESSMENT

Observations / Results

1. Medical facilities & services are not adequate for the community.
2. There are a few Traditional Birth Attendants (TBA) and traditional healers.
3. Some common prevalent diseases were Malaria, Dysentery/ Diarrhoea, cough/URTI Gastroenteritis, Rheumatism /Body pains, Hypertension and Hernia.

4. Some environmental conditions noted to contribute to ill health in the community were light/electricity supply and non- availability of potable water, and the borehole/well that the indigene rely on are owned by a few privileged individuals and from whom all others get water. Other environmental conditions are poor waste disposal practices, poor projects and the general absence of good modern-day medical care.

COMMUNITY CONCERNS ON HEALTH

1. The community needs a functional hospital with medical personnel, facilities and drugs.
2. They also need more readily available good drinking water, good electricity supply, good housing and all other modern facilities.

4.19 WASTE MANAGEMENT

There is poor waste management within the Polaku community, which is solely due to the fact that there is no Government approved waste collectors and as such wastes are still been dumped in the creek. People defecate in the Taylor creek.

Different categories of wastes will be generated during different phases of the proposed project. During the construction phase, the Contractor must make provision for the appropriate removal of waste from the site to a permitted waste disposal facility. The accumulation of construction waste materials on site must be avoided. The waste manager should be the one approved by Bayelsa State Ministry of Environment. The waste management within the Polaku community is generally poor as solid wastes are disposed in the Taylor creek. Some of the indigene pass faeces in the creek.

PHOTO 4.34: SOLID WASTE COLLECTED IN BAGS WITHIN POLAKU COMMUNITY

4.19.1 DISPOSAL OF CONSTRUCTION DEBRIS

Each phase of the development will produce solid waste, the disposal of which, if not managed properly could have negative impacts to the site and the surrounding area. Cut vegetation resulting from the clearing of the area could pose a fire hazard and affect air quality if burned on location. Other construction materials including concrete waste, wood, steel, packaging plastics could be dispersed and could end up blocking drainage channels if not disposed of at approved disposal sites.

4.19.2 SEWAGE AND GARBAGE DISPOSAL

Inadequate provision of portable restrooms and garbage collection bins at the construction site could lead to unsanitary conditions. Resulting impacts could vary from unsightly littering of the site, fly and pests' infestations to increased nutrient levels in the environment.

4.19.3 WASTE DISPOSAL FACILITIES / REDUCTION INITIATIVE

SOLID WASTE DISPOSAL

The solid wastes that shall be generated include:

- Empty Containers
- Printer's toners/inks cartridges
- Vegetation from landscaping & foundation laying
- Machine parts
- Stationary wastes (paper, writing materials etc.)

There should be a designated place for the collection of generated wastes where Government approved waste consultants collect and disposes them in the approved dumpsite.

4.19.4 WASTE REDUCTION / MINIMIZATION INITIATIVE

The waste minimization options that shall be adopted by the manufacturing plant include;

- Use of only good quality raw materials for production
- Optimal use of raw materials to achieve minimum waste generation
- Repair, reuse, sale of waste materials such as wooden pallets, metal scraps plastic kegs, defective products, packaging sacks and drums.
- Meticulous use of water and diesel; recovering and disposal of spent oil.
- Routine checks on pipes and fixtures for fugitive emissions and leakages.

4.19.5 APPOINTMENT OF AN ENVIRONMENTAL OFFICER

An independent Environmental Officer should be appointed to oversee all environmental aspects relating to the development. He should ideally be appointed during the planning phase and his/her responsibilities will include:

- Auditing of compliance with the EMP (the frequency of audits will be determined during the planning phase);
- Writing of auditing reports and submitting it to FME;
- Liaison with relevant authorities;
- Liaison with contractors regarding environmental management;
- Reviewing of the complaints register that is to be kept on site during the construction phase;
- Liaison with interested and affected parties when complaints need to be addressed;
- Limiting construction activities to the construction areas;
- Waste management;
- Legal compliance with all relevant environmental legislation;

The Environmental Officer shall have the right to investigate the site at any time during the project phases and unexpected visits will be permitted. Weekly/Monthly auditing reports shall also be made available to all the relevant parties.

CHAPTER FIVE

PUBLIC CONSULTATION

5.0 INTRODUCTION

The public participation process comprises an important step in identifying issues and expected impacts of the proposed development that may affect the natural and/or socio-economic environment. Consultation as part of the Environmental assessment process is a critical component in achieving transparent decision-making. Public consultations for the proposed composite LPG cylinder production plant were conducted as required in the Environmental Impact Assessment Decree. Door to door public consultations were conducted for the residents neighbouring the project site. Questionnaires were also distributed personally and through the Chiefs to the indigenes to enable us to get the opinion. Sixty (60) questionnaires were personally (besides those by the chiefs who suggested will reach the locals) distributed to cut across the youth, women, men/chiefs of the project area. The consultation and stakeholder's sessions were held between 24th -28th August 2020. The stakeholder's workshop was done limiting the number of participants while complying with NCDC Guidelines of social distancing. Everybody in attendance was presented with Nose mask.

PLATE 5.0: STAKEHOLDERS BTW FMENV, EIA CONSULTANT, PROJECT PROPONENT & HOST COMMUNITY OPINION LEADERS AT THE PROJECT LOCATION

PLATE 5.1: CROSS-SECTION OF COMMUNITY DURING PUBLIC CONSULTATION WITH PROJECT PROPONENT'S REPRESENTATIVE RESPONDING TO QUESTIONS

PLATE 5.2: FMENV ABUJA REPRESENTIVE MAKING COMMENTS DURING PUBLIC CONSULTATION

PLATE 5.3: FMENV ABUJA REPRESENTATIVE MAKING COMMENTS DURING PUBLIC CONSULTATION

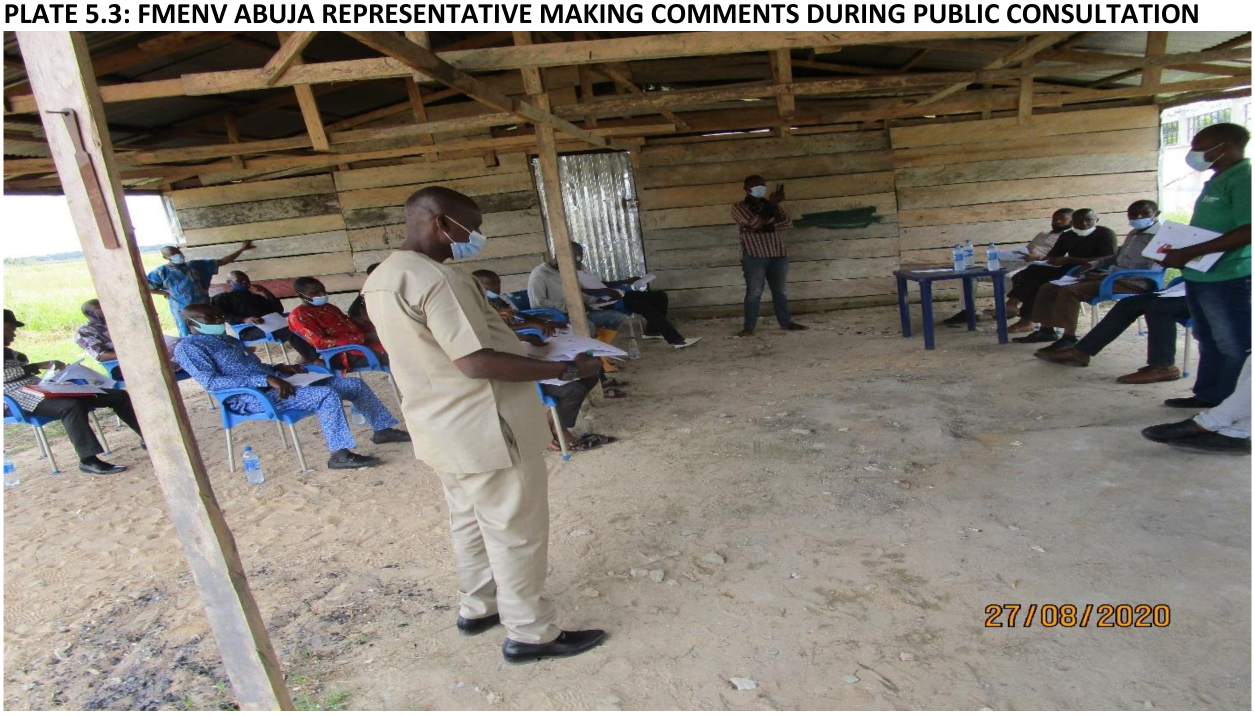


PLATE 5.4: REPRESENTATIVE OF EIA CONSULTANT MAKING PRESENTATION DURING PUBLIC CONSULTATION

PLATE 5.5: CROSS- SECTION OF INDIGENE DURING PUBLIC CONSULTATION

PLATE 5.6: CLOSING PRAYER SESSION DURING PUBLIC CONSULTATION

PLATE 5.7: GROUP PICTURE BTW REPRESENTATIVES OF FMENV, STATE MIN OF ENVIRONMENT, PROPONENT AND EIA CONSULTANTS DURING PUBLIC CONSULTATION.

PLATE 5.8: REPRESENTATIVES OF FMENV, STATE MIN OF ENVIRONMENT AND EIA CONSULTANTS DURING PUBLIC CONSULTATION.

PLATE 5.9: REPRESENTATIVES OF FMENV, STATE MIN OF ENVIRONMENT, EIA CONSULTANTS & COMMUNITY CHIEFS DURING PUBLIC CONSULTATION.

PLATE 5.10: REPRESENTATIVES OF FMENV, STATE MIN OF ENVIRONMENT, EIA CONSULTANTS & COMMUNITY YOUTHS DURING PUBLIC CONSULTATION.

PLATE 5.11: REPRESENTATIVES OF FMENV, STATE MIN OF ENVIRONMENT, EIA CONSULTANTS & UNIVERSITY OF NIGER DELTA TEACHING HOSPITAL.

PLATE 5.12: THE SECTOR COMMANDER-FEDERAL ROAD SAFETY CORP & EIA CONSULTANTS

PLATE 5.13: FOCUSED GROUP DURING SOCIO-ECONOMIC SURVEY WITHIN POLAKU COMMUNITY

5.1 OBJECTIVES OF THE CONSULTATION AND PUBLIC PARTICIPATION

The objective of the Consultation and Public Participation (CPP) is to:

- Disseminate and inform the public and other stakeholders about the proposed mixed residential, institutional, and recreational and facility support infrastructure project with special reference to its key components, location and expected impacts.
- awareness among the public on the need for the Environmental & Social Impact Studies for the proposed project.

  Gather comments, concerns, and suggestions of the interested and, would be affected/ interested parties.
- Ensure that the concerns of the interested and, would be affected/ interested parties were known to the decision-making bodies and the proponent at an early phase of project development planning.
- Establish a communication channel between the interested, would be affected/interested parties, the team of consultants and the Government.
- Incorporate the information collected in the study by ESIA Experts.

5.2 PROCESS OF ENGAGEMENT

Public, or stakeholders' and Interested and Affected Parties' (I&AP's) participation formed an integral part of this ESIA process. The main purpose of which was to:

- present the intended development as known to the consultants to all stakeholders, and IAP;
- provide stakeholders and IAP with information on the intended development that may bear directly on their health, welfare, and quality of life;
- enable stakeholders to make an informed and objective decision concerning the intended development;
- provide stakeholders and IAP the opportunity to raise their concerns regarding the intended development; and
- record the issues and concerns of stakeholders and IAP.

5.3 NOTIFICATION

The following means were used to inform stakeholders and I&AP's of the proposed development:

- The project was registered with the Federal Ministry of Environment, Abuja
- Letter of invitation for stakeholder's workshop
- Focused group discussion
- House to house consultation

5.4 OPPORTUNITIES

The following opportunities were available to contribute/comment:

- Registration of the Environmental & Social Impact Assessment with Federal Ministry of Environment by getting the list of requirements, preparation of Terms of reference and accompanied by evidence of Remita payment into single treasury account and communication with the consultant.
- Registering comments/concerns raised by stakeholders.

5.5 STAKEHOLDERS, INTERESTED AND AFFECTED PARTIES

Questionnaires were distributed to the residents and those that may be affected by the project for their comments within Polaku Community in Yenagoa. Notably, FRSC, Divisional Police Officer- Agudama, Chief Medical Director- Niger Delta University Teaching Hospital, Nigerian Content Development & Monitoring Board (NCDMB), Chairman Yenagoa Local Government Area, Ijaw Youth Council (IYC), Polaku, Gbarain Youth Federation, were also invited. Their comments were supporting the establishment of the project. The communities need the projects as it will improve on their welfare and means of livelihood.

5.5.1 NAMES OF SOME OPINION LEADERS INTERACTED WITHIN DURING CONSULTATION/ MEETINGS

Due to the Covid-19 Pandemic and in compliance with NCDC guidelines on social distancing, about twenty opinion leaders and organizations were invited and provided with nose mask for those who came without nose mask. The stakeholders’ workshop was conducted under an open roofed structure with well-spaced out seating arrangement in the proposed project site. All this is done to comply with the Covid-19 guidelines.

PLATE 5.14: WELL SPACED-OUT SEATING ARRANGEMENT FOR STAKEHOLDERS' WORKSHOP IN COMPLIANCE WITH NCDC COVID-19 PROTOCOL.

TABLE 5.0: LIST OF CHIEFS DURING CONSULTATION MEETING

S/N	NAMES OF PARTICIPANTS	DESIGNATION
1	Chief Tavi Club	Chairman, Polaku Community
2	Chief Mrs Aina Kenigia	Women Leader, Polaku
3	Miss Clever Teme-ere Deborah	Youth Women Leader
4	Hon. Profit Bibobara	Chairman, G/ECDB
5	Izonbodei Sukumowei	PRO/G/ECDB
6	Chief Dr K. Kwen	Former Izewaribo Chief, Polaku
7	Lucky Oderhohwo	MD/CEO, Rholuck Services Nig Ltd
8	Onoji John	Socio- Economic; Rholuck Services Nig. Ltd
9	Aliu Ojo Victor	Rholuck Services Nig Ltd
10	Ibekwe Valentine	Rungas Prime Ind Ltd-Project Mgr
11	Omovoh Gift Ochonogor	PSO-FMENV, Abuja
12	Rita Tuomokeme	S.O-FMENV, Abuja
13	Aleibiri Amatari	Regulator- FMENV, Bayelsa Regional Office
14	Inoyo John James	Director, Bayelsa State Min of Env
15	Tarilate Iyabi	GM-Rungas Prime Ind. Ltd
16	Paul Zitua	Pastor-Living Faith Church, Polaku
17	Chief Kenigua Dinikpete	Host- Compound Chief, Polaku
18	Comr. Kenigua Idubawo	Gbarain Youth Federation Rep
19	Woyigikuro Kenigua	Chairman
20	Kwen Manidongha	Laludi
21	Okoyonmu Thephilus	Sage Grey Limited, Rungas
22	Tonkumo Francis	PRO, Niger delta Uni Teaching Hospital

5.6 OUTCOME OF SOCIO-ECONOMIC SURVEY:

Questionnaire Administration during consultation

Questionnaires were also distributed to the indigenes to enable us to get the opinion. About Sixty-Six (66) questionnaires were personally distributed to cut across the youth, women, men/chiefs of the project area while guiding them how to fill the questionnaires. The response was okay as shown below. 63 responded to the questionnaire of the total number given. From the above Histogram, 20 respondents are within the age range of 18years to 30 years, 30 respondents within age 31 years to 50 years, 12 respondents within age 51years to 70years while 2 respondents are within 71 years to 90 years respectively.

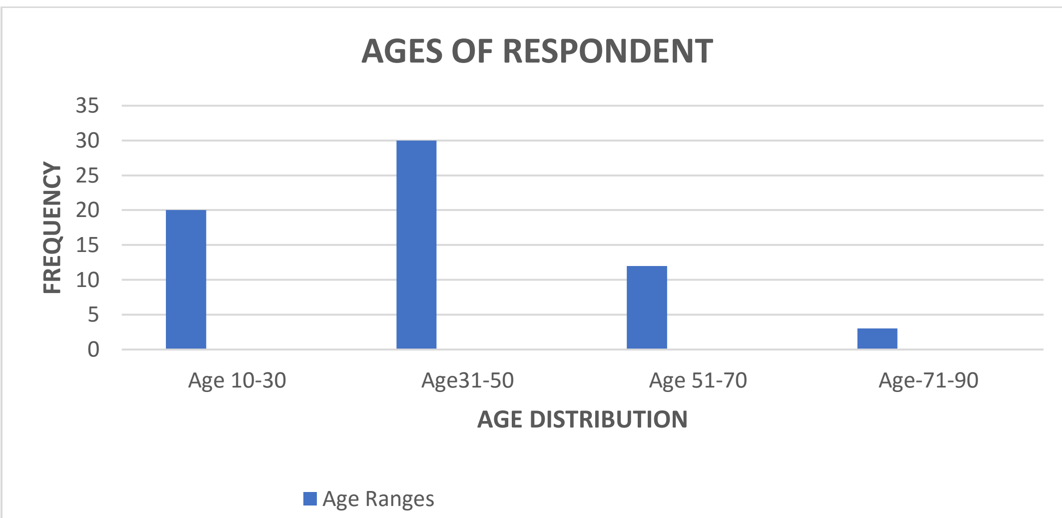


FIG 5.0: SOCIO- ECONOMIC SURVEY QUESTIONAIRE

INCOME PATTERN

About 66% of respondents fall within monthly Income less than N0.0-10,000, while 5% fall within a monthly income between N11,000-20,000. 7% respondents fall each within monthly income limit of N21,000- 30,000, while 8% falls within N41,000-50,000 monthly income and so on. Details are shown in Figure 5.1.

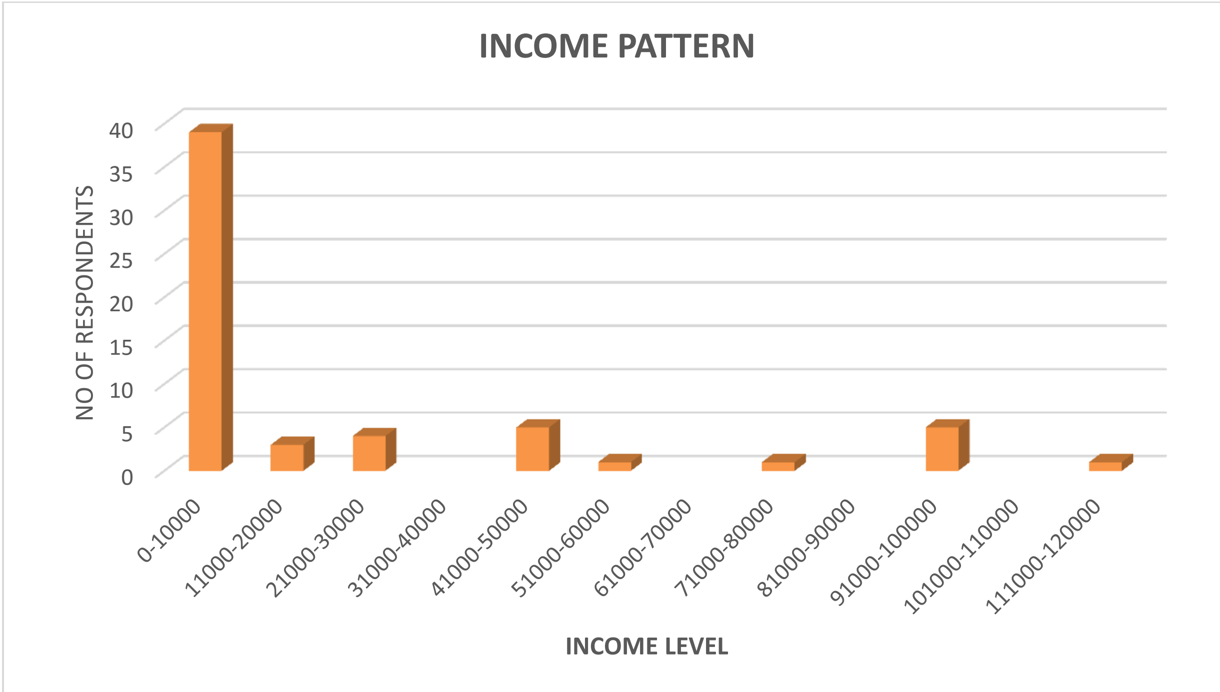


FIGURE 5.1: INCOME PATTERN OF POPULATION

HOUSEHOLD ITEMS OWNED BY INDIGENE:

From the survey, it was observed that most of the respondents do possess the radio/transistor, musical equipment, television, refrigerators, fans, cars, etc., this is shown as below.

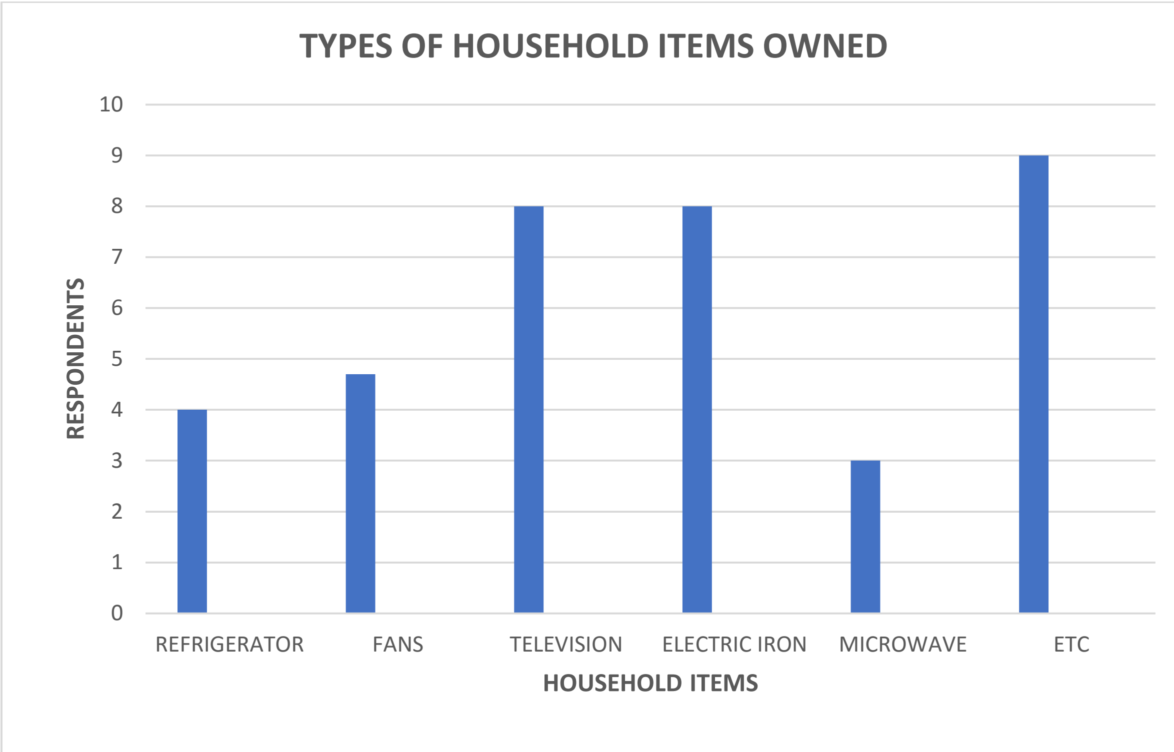


FIGURE 5.2: HOLDING OF DURABLE COMMODITIES

AVAILABLE FACILITIES

The population possesses electricity, but availability lived more to be desired, drinking water facility is borehole which is individually owned not well distributed and people still depend on the water from Taylor creek. From our survey, 62% of the community source of drinking water is from the River while 38% from individual / SPDC Borehole or purchase from local Vendors. The health care facility is over stretched. The ones provided by SPDC are no longer functioning.

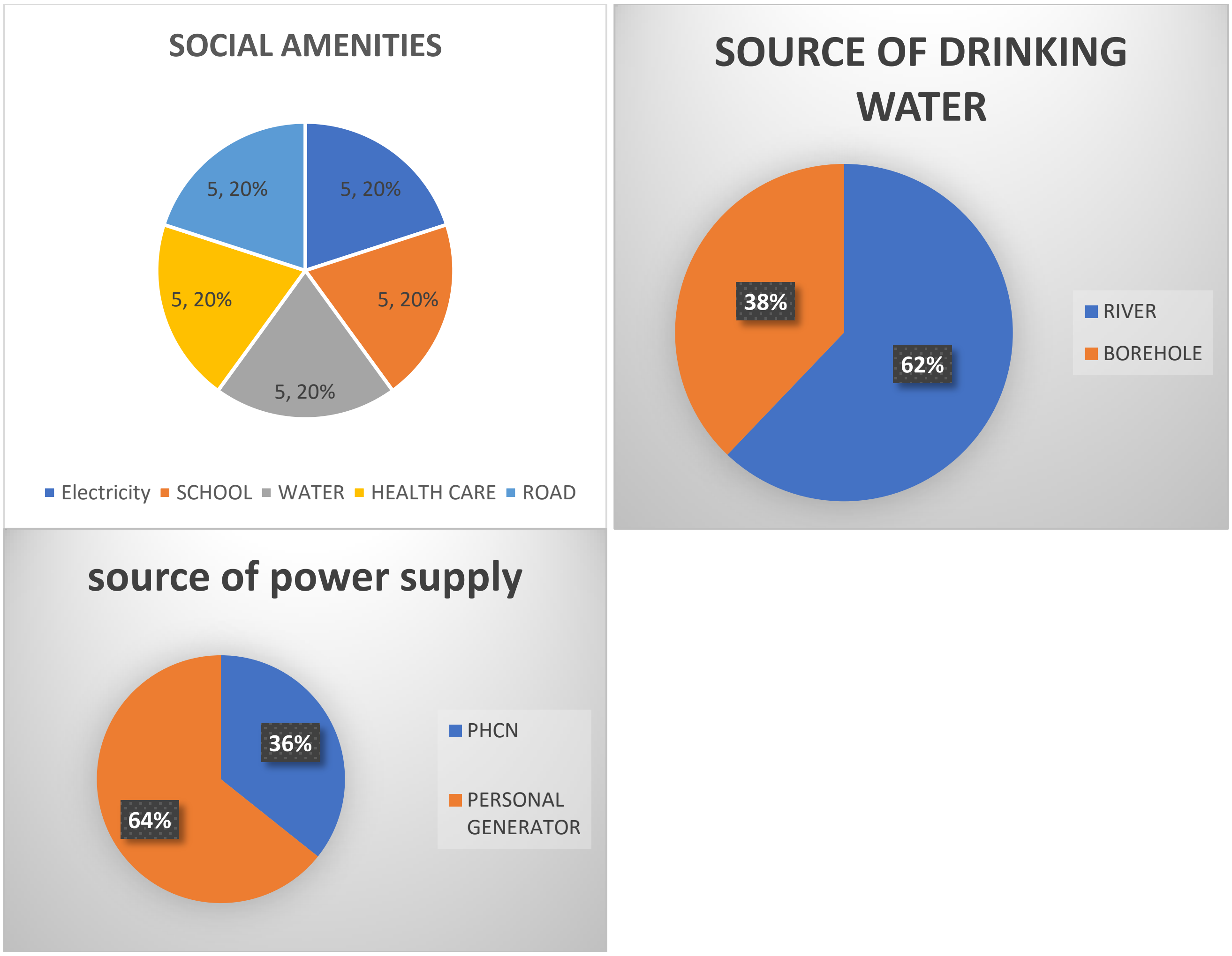
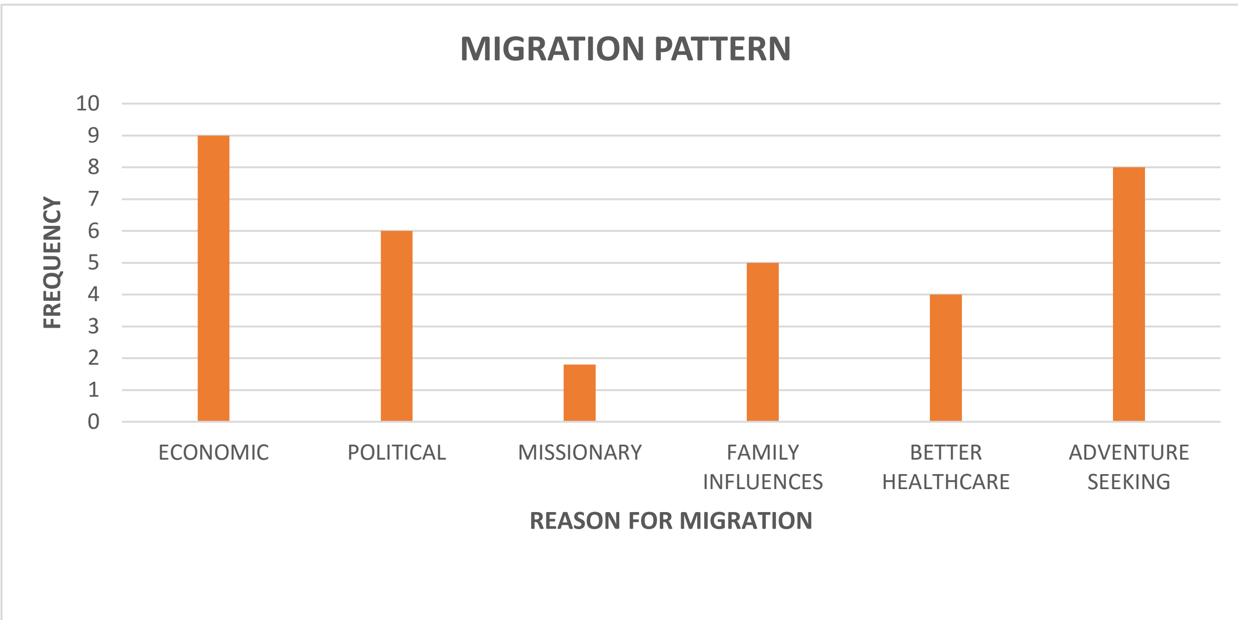


FIGURE 5.3: AVAILABLE FACILITIES

From the socio-economic survey, though there is power supply from the grid powered by the State Government in the community, but supply was not regular, therefore, about 64% of the source of power supply depends on individual personal Generator set.

MIGRATION:

From the socio-economic survey, there are reasons for migration out of Polaku community, such as for a better quality of life, to be close to the family or friends; missionary work seeking to promote religion outside the community. Family also influences their member to moves abroad for better adventure and many adventure-



seekers stay in other communities and start a new life in the chosen community.

FIGURE 5.4: MIGRATION PATTERN

WOMEN INVOLVEMENT

Women involvement has been observed in almost all the activities. Actively they are participating in different activities which is shown in figure given below.

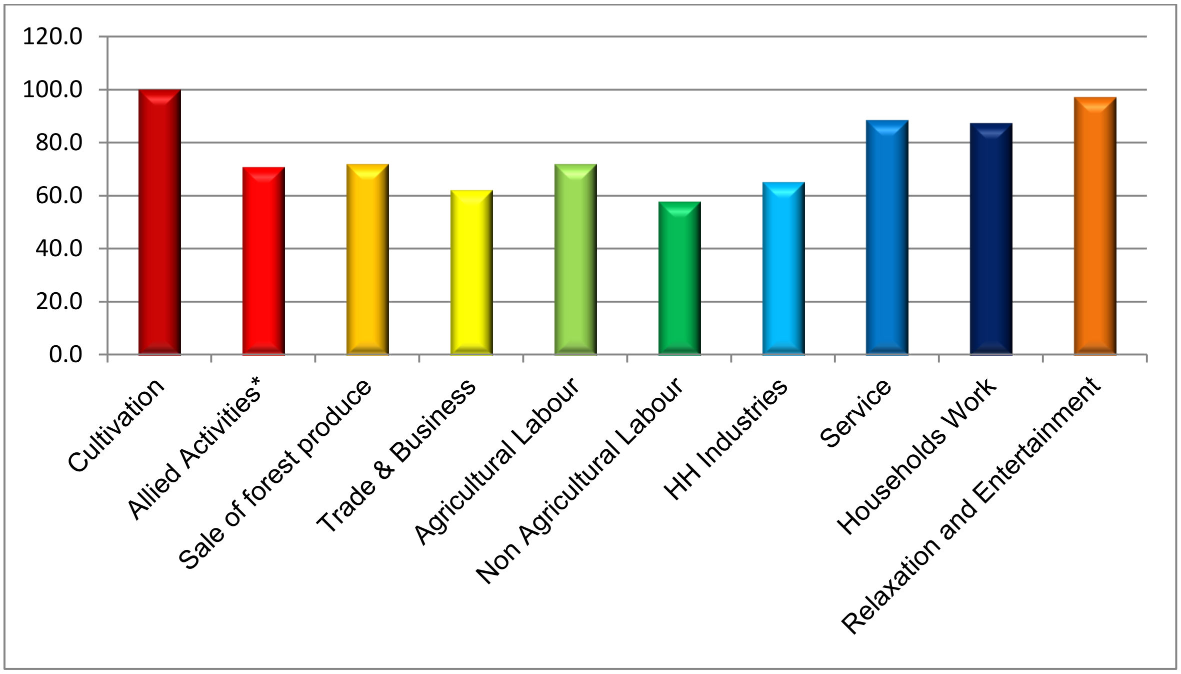


FIGURE 5.5: WOMEN INVOLVEMENT

WOMEN IN DECISION MAKING

Within the project area and the community, it was observed that women are involved in decision making in consensus with men. The sectors where women consensus with men involved in decision making in different sectors like:

- Family Financial Matters;
- Education to Child;
- Health care to child;
- Purchasing of any asset;
- Day to day activities;
- Social functions and marriages;
- Local governance

Male are the final decision maker in financial matters, purchase of asset and local governance. From our Survey in Polaku Community, women are not discriminated in any way, they are allowed to work and involved in decision making.

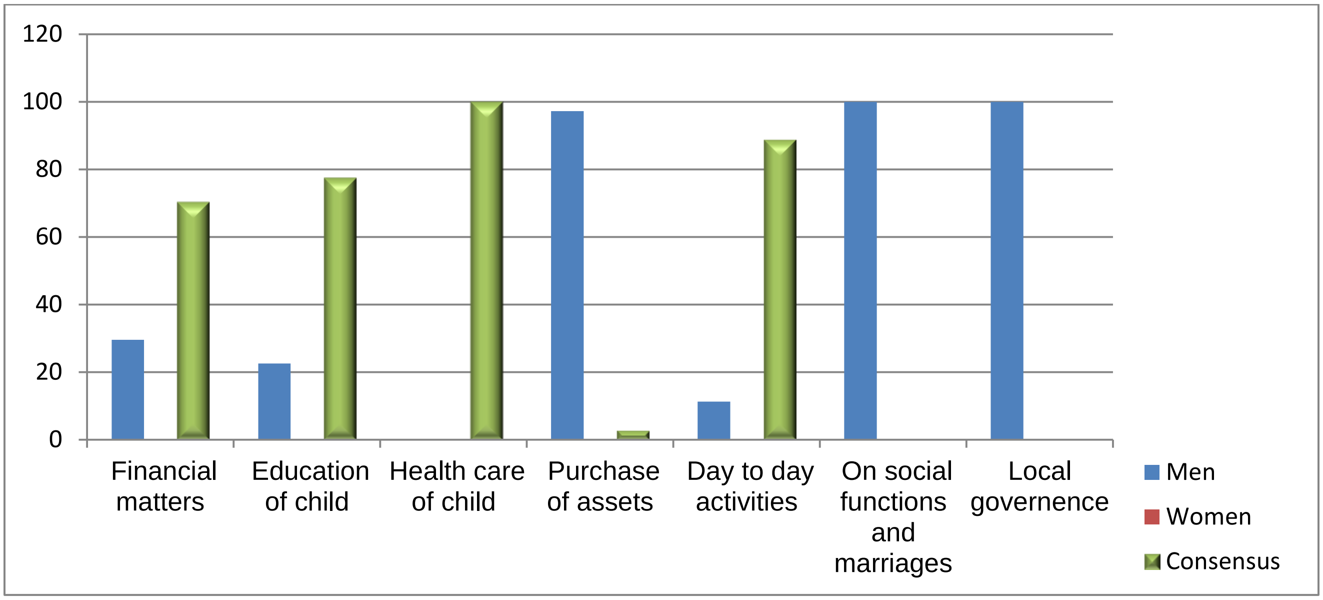


FIGURE 5.6: WOMEN AND MEN IN DECISION MAKING

EMPLOYMENT/UNEMPLOYMENT AND INCOME GENERATION SCHEME

Within and around the project area the main income generation activities that are being observed are (i) Farming; (ii) white collar jobs; (iii) petty trade (iv) local shop and selling of household products; (v) Block moulding, (vi) Fishing, (vii) Water transport, (viii) Weaving of fishing gears, (ix) Plaiting of hair, (x) Canoe carving, (xi) Carpentry, etc.

Some of the income generation activities in the project areas:

PLATE 5.13: INDIGENE WEAVING FISHING GEARS

PLATE 5.14A: A WOMAN PLAITING HAIR WITHIN POLAKU

PLATE 5.14B: A WOMAN PROCESSING CASSAVA WITHIN POLAKU

PLATE 5.14C: PROVISION STORE WITHIN POLAKU COMMUNITY

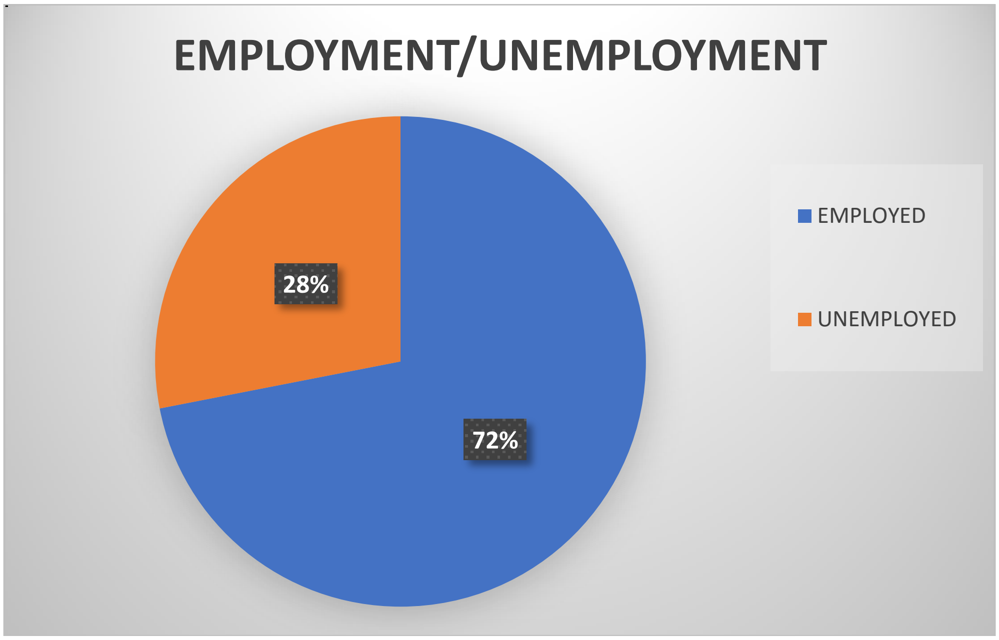


FIG 5.7: EMPLOYMENT AND UNEMPLOYMENT LEVEL WITHIN POLAKU COMMUNITY

From the survey, about 72% of the Population of Polaku community are working either as Civil Servant, self -employed, traders or Farming /Fishing. Meanwhile, 28% are applicant. The reasons for their unemployment was as a result of lack of companies and other sources of employment in the community.

COMMUNITY PERCEPTION ABOUT THE PROJECT

The Polaku community is in total support of the proposed project as it will create good business and employment opportunities to the host community. From survey, the Host community are of the opinion that once the proposed project is established, it will bring about creation of jobs, improve general wellbeing of the host community, availability of LPG cylinders to Nigerians. The project is a welcome development in the community.

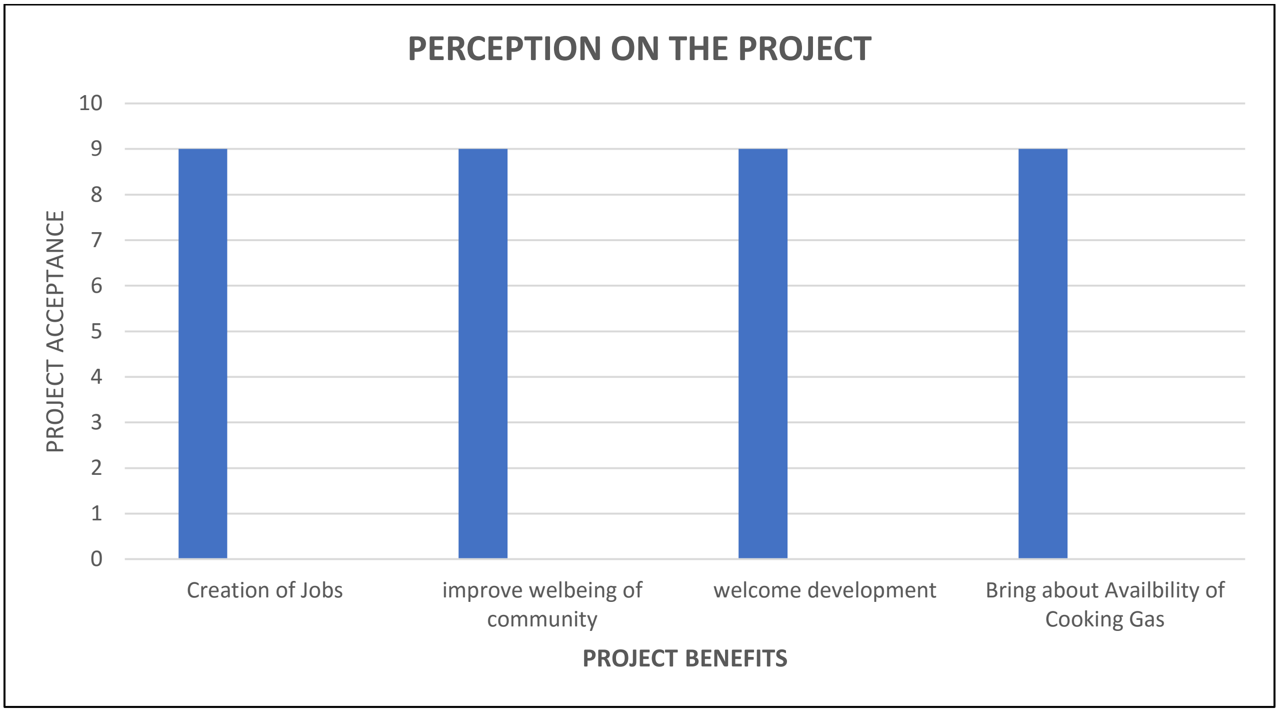


FIG 5.8: HOST COMMUNITY'S PERCEPTION ABOUT THE PROJECT

HEALTH IMPACT ASSESSMENT (HIA)

The health of a community is the cumulative health status of the individual person in Polaku community. The health status of the community is affected by various contributing factors in the environment as well as within the household. The physical environment, income level, level of education, social support system, individual metabolism and genetics as well as individual health habits and available health services all determine the health of Polaku community. Th health impact assessment of the host community was done during the environmental study. The report reflects the poor quality of health care available in the study area. A closer look at the health seeking behaviour of the study population revealed that self-medication; visits to patent medicine stores, traditional birth attendants and alternative medical practice are key practices that define their health care situation.

MORBIDITY AND MORTALITY

Several factors contribute to define the morbidity and mortality pattern of a given community. Such factors include poverty, infections, inadequate health facilities, poor housing, unsanitary environmental conditions and nutrition. Survey results indicate that members of the study communities suffer from several conditions and sicknesses. The most common conditions include: Malaria, diarrhea diseases (including dysentery), tuberculosis, respiratory tract infections, typhoid fever, and hypertension.

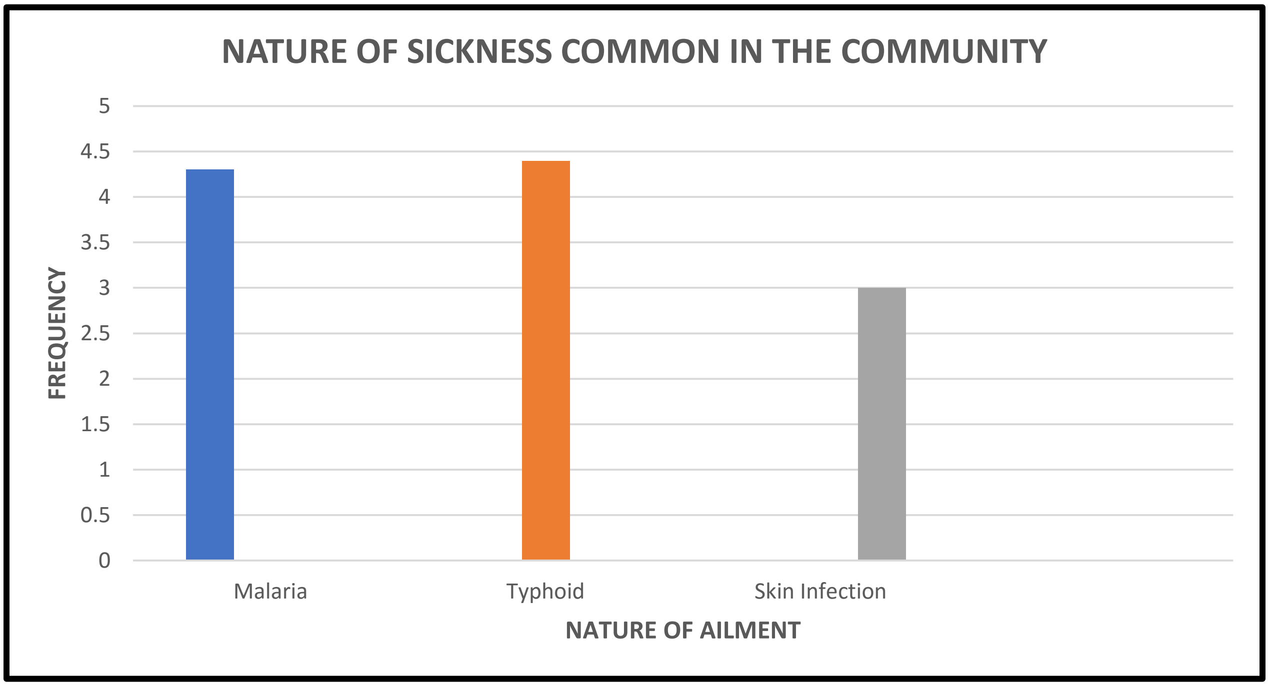


FIG 5.9: NATURE OF SICKNESS COMMON WITHIN POLAKU COMMUNITY

CHAPTER SIX

ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACTS

6.0 INTRODUCTION

This Chapter contains summary of impacts that are inherent with the project because of the interaction between various project components and environmental elements. The method of impact identified and evaluated is also given in this chapter. A number of potential impacts associated with the proposed development have been identified through the public participation process, baseline data acquisition process and biophysical specialist assessment. The impacts cover all project phases, i.e. planning and design, preconstruction, construction, and operation. Environmental impacts can be direct or indirect and they are either positive or negative in nature. Direct impacts are impacts directly associated with the projects; its effects are felt immediately as a result of initiating the project. While indirect impacts are consequences not directly caused by the project, but its existence indirectly lead to some effects. All these forms of impacts were identified, and mitigation measures are initiated.

6.1 IMPACT QUANTIFICATION AND DETERMINATION OF SIGNIFICANT IMPACTS

Hazards can be assessed by:

- Identifying all materials stored which are classified as hazardous, their quantities and proposed safe storage and handling (e.g. fuel, raw materials, lubrication oils for maintenance and laboratory testing chemicals);
- Identifying potential hazards from fire, explosion or release of chemicals or polluted waters, natural occurrences such as floods, storms, and landslip. (e.g. handling of fuels and packaging using high pressure, protection of storages from runoff waters, maintenance of discharge system for effluents, maintenance of machinery and abatement for air emissions, prevention of dust emissions from fugitive sources –like covering of transfer points and conveyors, water spraying point sources, paving, road wetting and wind barriers for open piles);
- Identifying potential risks to local people and local resources in the event of an emergency.

During the environmental impact assessment process, the identified inherent impacts of the proposed project were quantified using the Risk Assessment Matrix and the ISO 14001 procedure for evaluation and registration of Environmental Aspects and identifying significant environmental aspects/impacts. Criteria and Ratings for Identifying Significant Environmental Impacts of the project are as follows:

Legal / Regulatory Requirements (L) – is there a legal/regulatory requirement or a permit requirement?

0 = There is no legal/regulatory requirement

3 = There is a legal/regulatory requirement

5 = There is a permit required

Risk (R) – What is risk/hazard rating based on Risk Assessment Matrix (RAM) (**Figure 6.0, Tables 6.1 & 6.2**)?

1= Low risk

3 = Medium/intermediate risk

5 = High risk

Environmental Impact Frequency (F) – What is frequency rating of impact based on RAM?

1 = Low frequency

3 = Medium / intermediate frequency

5 = High frequency

Importance of Affected Environmental Component and Impact (I) – What is the rating of importance based on consensus of opinions?

1 = Low importance

3 = Medium/intermediate importance

5 = High importance

Public Perception (P) – What is the rating of public perception and interest in facility and impacts based on consultation with stakeholders?

1 = Low perception and interest

3 = Medium/intermediate perception and interest

5 = High perception and interest

The significant potential impacts of the facility were identified.

(L+R+F+I+P) ≥15**:** Sum of weight of legal requirements. Risk factor, frequency of occurrence, importance, and public perception greater than or equal to the benchmark (15).
(F+I) is >6**:** Sum of weight of frequency of occurrence and importance of affected environmental component exceeds the benchmark (6).
P=5: The weight of the public perception/interest in the potential impact exceeds the benchmark (5).

6.2 PROJECT RISK ASSESSMENT

Risk Assessment is a special assessment tool or procedure that aims at managing uncertain consequences of anthropogenic(human) activities. Risk analysis is the measurement of the likelihood and severity of harm. Risk analysis is usually made up of risk identification and risk estimation; the latter is the attempt to estimate scientifically, mathematically, statistically, or by some other rigorous procedure the probabilities of an event and the consequences associated with it. Generally, risk analysis is the most time-consuming, costly and technically difficult part of risk management, requiring data collection and analysis, in areas where needed data often do not exist and where analysis of these data is more of an art than a science. Because risk analysis often involves probabilities, statistics and epidemiological data, it may be difficult to convey the results of an analysis to the public and to non-specialists.

Two key benefits of Environmental risk assessment (ERA) within EIA, discussed further below, are that it provides a means to:

i. systematically identify potential hazards of the proposed project and scope the detailed investigations required for the EIA; and,
ii. set EIA priorities and manage uncertainty.

The field of risk analysis has assumed increasing importance in recent years given the concern by both the public and private sectors in safety, health, and environmental problems. Risk analysis encompasses three interrelated elements: risk assessment, risk perception and risk management.

RISK: Risk can be defined as “the chance of something happening that will have an impact on objectives or proposed project or on the community. A risk is often specified in terms of an event or circumstance and the consequences that may flow from it. Risk is measured in terms of a combination of the consequences of an event and their likelihood".

"Likelihood" describes how often a hazard is likely to occur and is commonly referred to as the probability or frequency of an event. However, the consequence describes the effect or impact of a hazard on a community. Both likelihood and consequence may be expressed using either descriptive words (i.e. qualitative measures) or numerical values (i.e. quantitative measures) to communicate the magnitude of the potential impact.

The calculation of risk can be given as: **R= L x C**

where R is the risk (for environment), C is severity of harm environment (consequence), L is the likelihood of the occurrence of that harm.

6.2.1 PROPOSED PROJECT RISK PARAMETERS

In environmental risk assessment, there are basic parameters that should be targeted to enable effective risk mitigation measures. These parameters are the climate and meteorology, air quality, noise levels, groundwater, geology and geomorphology, soils and soil erosion, drainage patterns and flooding, unique physical features, and aquatic ecosystem, vegetation, land use cover etc.

6.3 ASSESSMENT CRITERIA

The criteria developed for the assessment of the affected environment is based on the requirements as stipulated by the regulatory Agencies, regulations, and WHO regulations.

'It seeks a balance that promotes economic development on the one hand and the conservation of visual, aesthetic, tourism, environmental and heritage characteristics and resources of the study area on the other hand.

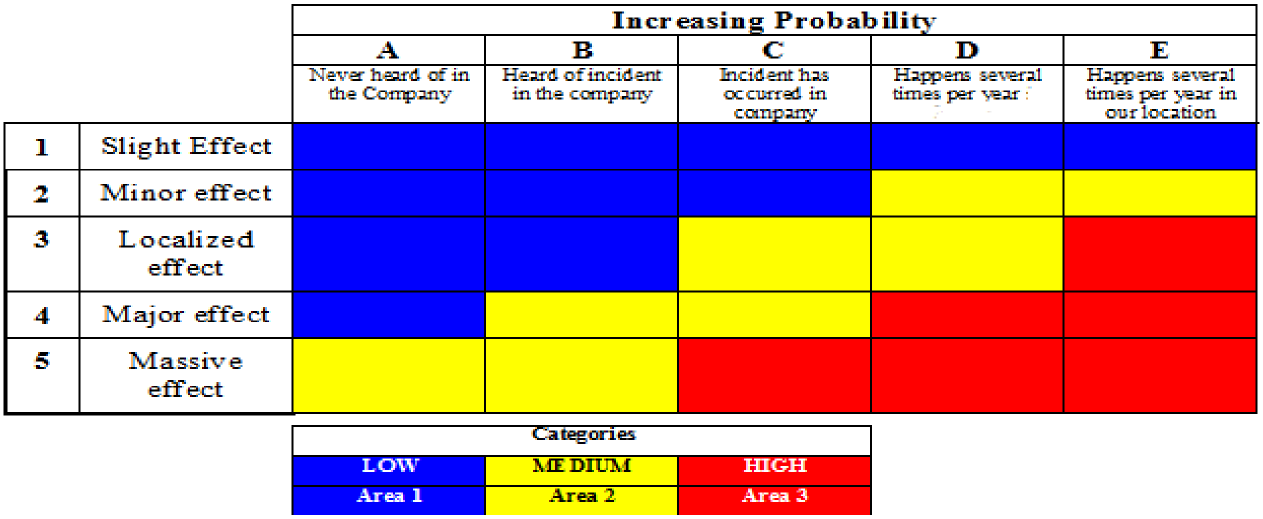


FIG 6.0: RISK ASSESSMENT MATRIX (RAM) FOR ENVIRONMENTAL CONSEQUENCES

TABLE 6.0: DEFINITION CONSEQUENCE CATEGORY (DAMAGE TO ENVIRONMENT)

Hazard Rating	Definition Consequence Category (Damage to environment)
1	**Slight environmental effects (Zero effect):** Local environmental damage within the fence and within systems. Negligible financial consequences.
2	**(Minor Effec**t) Contamination, damage sufficiently large to affect the environment single exceeding statutory or prescribed criteria, single complaint. No permanent effect on the environment
3	**(Localized Effect) Limited loss of discharges of known toxicity**. Repeated exceeding statutory or prescribed limit. Affecting neighbourhood
4	**Severe environmental damage (Major effect).** The company is required to take extensive measures to restore the contaminated environment to its original state. Extended exceeding statutory or prescribed limits
5	**Persistent severe (Massive effect) environmental damage** or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservancy, a major economic loss for the

	company. Constant high exceeding statutory or prescribed limits.

TABLE 6.1. RELEVANT CRITERIA FOR RISK CALCULATION

Stressor: Emission	**IMPACT TO ATMOSPHERE**		
	Likelihood	**Level (L)**	**Emissions of particulate matter**
	negligible	1	< 1
	low	2	1 - 5
	medium	3	5 - 10
	high	4	> 10
	Consequence	Category „C“	The concentration of PM_{10} in the air [$\mu g.m^{-3}$]
	negligible air pollution	1	< 15
	low air pollution	2	15,01 – 20,00
	medium air pollution	3	20,01 – 4000
	high air pollution	4	> 4001
Stressor: Waste water	**IMPACT TO WATER ENVIRONMENT**		
	Likelihood	Level (L)	Number of population equivalent
	negligible	1	< 2 000
	low	2	2 001 – 250 000
	medium	3	250 001 – 500 000
	high	4	> 500 001
	Consequence	Category ©	Quantity of discharged wastewater [$.10^3\ m^3.y^{-1}$]
	slight pollution of stream	1	< 200

	medium pollution of stream	2	< 1 000
	heavy pollution of stream	3	< 15 000
	extreme pollution of stream	4	> 15 000
Stressor: Floods	**IMPACT TO WATER ENVIRONMENT**		
	Likelihood	Level „L“	Total average monthly precipitation in % of normal for the year
	negligible	1	< 100
	low	2	101 - 110
	medium	3	111 - 120
	high	4	> 121
	Consequence	Category (C)	Number of days with the achieved degree of the flood activity
	endangered area	1	0 – 10
	medium threatened area	2	11 – 50
	highly threatened area	3	51 – 100
	extremely threatened area	4	> 101

Environmental Impact Assessment is an essential tool for the sustainable management of environmental resources. A new approach to environmental impact assessment, based on method of risk analysis has been present. We have always faced many challenges in dealing with environmental risks. Successful risk analyses require scientists and engineers to undertake assessments to characterize the nature and uncertainties sur-rounding a particular risk. One also needs social scientists to characterize the factors that influence the perception of a risk. Finally, there is a need for develop strategies that involve risk communication, eco-nomic incentives, standards and regulations for the managing these risks.

We have used risk criteria to define the acceptable risk level for the environment. We cannot expect to achieve a risk level equal to zero. Thus, defining which level of risk considered as acceptable for the environment been analysed. The risk criteria should be based on the acceptability requirements for the environment.

6.4 ANTICIPATED ENVIRONMENTAL AND SOCIAL IMPACTS

The environmental impacts caused due to the development of the project can be categorized as primary (direct) and secondary (indirect) impacts. Primary impacts are those which are induced directly by the project whereas the secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns of social and economic activities due to the proposed action. Interaction of the project activities with environmental attributes is presented as Activity-Impact matrix in **Table 6.2.**

Potential direct and indirect impacts of the project during construction phase will be the following:

- Filling in low-lying areas for embankments of the project area.
- Loss of vegetation due to cutting of trees
- Loss of Topsoil due to Clearing & Grubbing of new alignment.
- Temporary impacts in terms of polluted environment on flora and fauna due to the construction activities.
- Impacts on the drainage pattern due to raised embankment, introduction of new culverts.
- Impacts on traffic management system.
- Increased air pollution (including dust) during project construction.
- Increased noise level due to the movement of vehicles and construction activities.
- Increased soil erosion.
- Oils spills and other hazardous materials.
- Pollution of surface and sub-surface water sources.
- Pollution due to generation of spoils and solid waste.

Potential direct and indirect impacts of the project during operation phase are the

following:

- Increased noise pollution due to the vehicular movement.
- Impact on natural drainage pattern of the project area.
- Pollution of water bodies and impacts on its ecosystem due to hazardous chemical or oil spillage into the canals and streams.

The positive impacts of the project will be:

- Reduced air pollution due to better service levels of the Industrial hub.
- Generation of local employment.
- Improvement of local economy and industry due to better infrastructure facilities.

TABLE 6.2: ACTIVITY - IMPACT IDENTIFICATION MATRIX

S/N	Activities	Impacts on Physical Environment			Biological Environment		Geology		Topography
		Air	Water	Noise	Flora	Fauna	Natural Drainage	Soil	
A.	**Construction Phase**								
1	Labour Camp Activities		-Ve/T						
2	Quarrying	-Ve/T		-Ve/T	Ve/T		-Ve/T		-Ve/P
3	Material Transport & Storage	-Ve/T		-Ve/T					
4	Earthwork						-Ve/T	-Ve/T	-Ve/T
5	Pavement Works	-Ve/T	-Ve/T	-Ve/T	-Ve/T			-Ve/T	-Ve/P
6	Use of Construction Equipment	-Ve/T	-Ve/T	-Ve/T		-Ve/T			
7	Plantation	+Ve/P		+Ve/P	+Ve/P				
8	Drainage Works						+Ve/P		
9	Stripping of Top Soil								
10	Debris Generation						-Ve/T		
B.	**Operational Phase**								

S/N	Activities	Impacts on Physical Environment			Biological Environment		Geology		Topography
		Air	Water	Noise	Flora	Fauna	Natural Drainage	Soil	
1	Vehicular Movement	-Ve/P		-Ve/P	-Ve/P	-Ve/P			
2	Impacts on forest areas including wildlife sanctuary, national park	No Wild Life Sanctuaries, Forests and any other eco-sensitive areas are present along the Industrial hub							

Note: T - Temporary; P - Permanent.

As part of the project there will be some construction stage impact to the local site and water bodies which can be taken care by the onsite environmental management measures as suggested in ESMP. The general Environment, Health and Safety guidelines of international standard will be followed to ensure that the workers are provided with adequate health and safety facility and are provided with safe drinking water, sanitation, and medical facilities as and when required. As part of the project HIV/AIDs awareness will also be undertaken in the villages as well as among the construction workers.

The project area is not bordering any natural stream or water body and is also does not involve any kind of diversion of forest land. The project impacts are confined within the proposed location earmarked as industrial hub. The impacts on the various environmental components can occur at any of the following stages of the project planning and implementation:

- Planning and design stage
- Construction stage and
- Operation stage

TABLE 6.2: SIGNIFICANT IMPACTS OF PRODUCTION PLANT

PROJECT ASSOCIATED IMPACTS		ASSESSMENT CRITERIA					TOTAL SCORE L+R+F+I+P	CATEGORY
PROJECT ACTIVITY	**POTENTIAL IMPACTS**	**L**	**R**	**F**	**I**	**P**		
Horticulture (Site Survey, Soil Testing, Bush Clearing)	The removal of vegetation will expose the soil to weather conditions and there is the tendency for migration of wildlife	0	1	1	1	1	4	Not Significant
Production & Maintenance Phase (Trenching, block work, Pipe laying, Back filling, Transportation of materials, equipment, and personnel, Operations of machines and vehicles)	- Damage to underground utilities during Excavation	1	1	1	1	1	5	Not significant
	- Change in water quality due to inflow of run-offs, suspended particles etc.	1	1	1	1	1	5	Not significant
	- Changes in noise and exhaust gases from excavators. Increase in dust during the dry season.	3	3	1	3	3	13	Significant
	- Increase in turbidity due to expose of soil surface run-offs carry sediment drainage pattern due to changes in topography and improper re-instatement.	1	1	1	1	1	5	Not Significant
	- Road users would be exposed to higher road incidents due to increase in heavy traffic.	3	3	3	3	3	15	Significant
	- Temporary road obstructions/diversions - Emission of exhaust gases from the fuel combustion engines can alter the local ambient air quality.	1	1	1	1	1	5	Not significant
	- Soil contamination and loss	1	1	1	1	1	5	Not

	of aesthetics from liquid leaks,							significant
Operation Phase (Production, Disposal of industrial and domestic wastes, Maintenance)	- Contamination of soil and water system with effluent and used oil resulting from maintenance activities. - Odour and aesthetic devaluation may result from improper handling. Increase in disease if dumped in water - Release of gases into the atmosphere - Accidental damage to equipment leading to fire incident	1	1	1	1	1	5	Not Significant

6.5 PHYSICAL ENVIRONMENT

6.5.1 Climatological Parameter

Though no change in the macro-climatic setting (precipitation, temperature, and wind) is envisaged due to the project, the microclimate is likely to be temporarily modified by vegetation. There will be an increase in daytime temperature arising from some heat that will be generated from the factory and soil due to loss of shade and vegetation, which in turn might lead to formation of heat islands especially along the inhabited sections. However, it may be pointed out that the entire stretch is blessed with natural vegetation on either side of the industrial hub and hence the impact on meteorological parameter will be temporary in nature and with the growth of vegetation such impact will be minimized to a large extent.

6.5.2 Physiography and Land Use

Pre-construction and Construction Stage

Project activities involve alterations in the local physiography and drainage patterns. The impacts on physiography may include de-stabilization arising from slopes due to cut and fill operations. Cut-and-fills will be designed for improvement to the area geometry, and drainage structures will be added to improve drainage.

6.5.3 Geology and Seismology

Pre-Construction, Construction and Operation Stage

The available seismic information of the state indicates that the project area is free of earthquake and do not have any such history. The project will not pose impact on geology and seismic condition.

6.5.4 Soil Erosion

Pre-construction Stage

The removal of vegetation will cause erosion, and increased run-off would in turn lead to erosion of productive soil. The direct impact of erosion is the loss of embankment soil and danger of stability loss for the project. This impact is generally restricted within the project location. The project has taken care of this issue at the engineering design stage.

Construction Stage

Elevated sections particularly at high embankments would be vulnerable to erosion and need to be provided proper slope protection measures to prevent erosion. If the residual spoil generated during the up gradation of cross drainage structures are not properly disposed of then chances of increase in downstream sedimentation is likely. However, these impacts are temporary impacts and are limited to the construction period only and with improved design the drainage in the area are expected to be improved.

Silt fencing to be provided to prevent eroded material from entering watercourses and the Taylor Creek. The regular cleaning of the drains will ensure that these structures will not be overloaded or rendered ineffective due to overload.

Operation Stage

No soil erosion is envisaged when the project is in full operation as all the slopes and embankments of the project shall be stabilised through sound engineering techniques.

6.5.5 Contamination of Soil

Construction Stage

Contamination of soil during construction stage is primarily due to construction and allied activities mostly from the site where construction will take place etc. The construction camps generate solid waste and wastewater which may contaminate the soil.

The sites where constructions vehicles are parked and serviced are likely being carried out have chances of contamination due to leakage or spillage of fuel and lubricants. Pollution of soil can also occur in hot-mix plants from leakage or spillage of petroleum products. Refuse and solid waste from construction activities also contaminate topsoil. Contamination of soil during construction might be a major long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to water bodies in case of dumping being done near water body locations. Such contamination issues can be minimized through proper working measures and unauthorized disposal of contaminated materials as being suggested in ESMP.

Operation Stage

During the operation stage, soil pollution due to accidental vehicle spills or leaks is a low probability as one of the main objectives of the project is to reduce accidents, but potentially disastrous to the receiving environment if they occur. These impacts can be long term and irreversible depending upon the extent of spill. There should be an emergency management plan in case of such major spills occurring.

6.5.6 Air Pollution

The project has different phases, preconstruction, construction & operation phases and would create:

- Impact on air quality both during the construction and operation stages of the project.
- Impact during construction stage and will be of short term and have adverse impacts on the construction workers as well as the settlements adjacent to the project area, especially those in the down wind direction.

- Impacts during operation stage
- Both the construction and operation stage impacts can be effectively mitigated if the impacts have been assessed with reasonable accuracy in the design stage.

6.5.7 Generation of Dust

Pre-construction Stage

Generation of dust is the most likely impact during this stage due to:

- Site clearance and use of heavy vehicles and machinery etc.;
- Procurement and transport of raw materials and quarries to construction sites;
- The impacts will mostly be concentrated within the Industrial hub.

If adequate measures such as sprinkling of water on projects sites where clearance and excavation activities are on, covering material trucks especially those carrying sand and fly ash, then the impacts can be reduced. It is likely that impacts due to dust generation are felt downwind of the site rather than on the site itself.

Construction Stage

As the entire project area has a soil type with high sand & silt content and the construction activities to be carried out during the rainy & dry season when the moisture content would be less, dust generation, particularly due to earthworks will be significant during dry season. Dust is likely to be generated due to the various construction activities including:

- Supply of construction materials;
- Handling and storage of raw materials;
- Concrete batching plants; and
- Construction and allied activities.

Generation of dust is a critical issue and is likely to have adverse impact on health of workers within the site, and concrete works. The proposed project site is secluded from the residential areas and as such acts as a buffer zone for dust generation. Regular sprinkling of water will suppress such dust generation to a large extent.

Operation Stage

- No dust generation is envisaged during the operation stage at least in the built-up section as all site are proposed to be paved and all slopes and embankments shall be turfed as per best engineering practices.

6.5.8 Generation of Exhaust Gases

Pre-construction Stage

The generation of exhaust emission gases is likely during the pre-construction stage due to some movement of construction vehicles.

Construction Stage

High levels of carbon monoxide (CO), Temperature and hydrocarbons are likely from plant operations. Although the impact is much localised, it can spread downwind depending on the wind speeds. The impact largely get reduces once the plant is located to a large distance from the local habitation. The Environment Management Action Plan prepared need to ensure adequate measures are being taken especially for health and safety of workers such as providing them with respirators during working hours. Also, the contractor should ensure that hot mix plants, stockyards, etc. are away from residential areas and residential quarters of all workers. If adequate measures are taken, then impacts from generated gases can be negligible.

Operation Stage

The impacts on air quality will at any given time depend upon vehicular movement and emission from equipment within a given stretch and prevailing meteorological conditions.

Air pollution impacts arise from two sources:

i) inadequate vehicle maintenance; and

ii) use of adulterated fuel in vehicles. Enforcement standards to meet better vehicle performance in emissions and the improvement of fuel constituents can assist in improving regional air quality.

Dust Control

All precautions to reduce the level of dust emissions from the hot mix plants, crushers and batching plants and other transportation of materials will be taken up including:

- Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing projects.
- Water will be sprayed on earthworks where there is the likelihood of dust emission.

Emission Control

To ensure the control of exhaust emissions from the various construction activities, the civil contractor shall take up the following mitigation measures:

- An adequate emissions control measures shall be in place to ensure every emission sources/ activities are checked.
- To ensure the efficacy of the mitigation measures suggested, air quality monitoring shall be carried out quarterly during the period the plant will be in operation.
- All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the FMENV/ Bayelsa State ministry of environment requirement.

Operation Stage

During the operation stage, the mitigation required is directed more on the facilities for checking levels of pollution. Additional measures proposed are as below:

- reduction of equipment and machinery emissions,
- ensuring vehicular maintenance,
- educating drivers about driving behaviour and methods that will reduce emissions.

6.5.9 Water Resources

There is likely going to be direct impact on the surface water (Taylor Creek) that may arise from various construction activities during the construction stage as well as project operation stage. The potential impacts on water resources are summarised below.

Table 6.3: Likely Impacts on Water Resources during the Construction Stage

Impacts due to Construction	Indicators
Loss of water bodies	Area of water bodies affected
Loss of other water supply sources	Hand pumps, wells etc. affected
Depletion of ground water recharge	Groundwater in area rendered inaccessible & impervious
Use of water supply for construction	Quantum of water used
Contamination from fuel and lubricants	Nature and quantum of contaminators
Contamination from improper sanitation and waste disposal in	Area of camp / disposal site and proximity to water bodies / channels

Impacts due to Construction	Indicators
construction sites	

Loss of Water Resources

Loss of water resources includes removal of private and community water resources like hand pumps, water taps, etc. There is no loss of this nature during the construction and operation phase.

Drainage and Hydrological flow

There is Taylor creek and the Nun river with confluence at the upstream within the project area, naturally rain runoff is towards the creek and due to the sound engineering consideration there is likely going to be temporary water flow into the creek. There is a good drainage network within the project location and specific drainage structures are proposed within the project area.

Protection from Run off

Surface run-off is discharged into natural/artificial drains of adequate capacity from ditches at the end of formation to prevent destabilization of the embankment. Scouring of banks of flowing water bodies due to high velocity run-off is also a potential danger, but there is no such area where there is an existing detrimental surface run-off.

Protecting Water Quality

To prevent any degradation of water quality of the various surface and ground water resources due to the proposed project, the proponent shall work out the following mitigation measures during the construction period: Provision of necessary mitigation measures at the various locations proposed in the design to prevent contamination and degradation of water quality.

- The fuel storage and vehicle cleaning area shall be stationed at least 500m away from the nearest drain / water body.
- The slope of the embankments leading to water bodies shall be modified and re-channelled to prevent entry of contaminants into the water body.
- Provision of silt fencing and oil interceptors the details of which are given below

Silt Fencing

Where necessary, silt fencing shall be provided to prevent sediments from the construction site entering any watercourse. The silt fencing consists of geo textile with extremely small size supported by a wire mesh mounted on a panel made up of angle / wooden frame and post. It is expected a single person will be able to drive the angles by pressing from the top. The frame will be installed at the edge of the water body along which construction is in progress.

Oil interceptor

Oil and grease from run-off is another major concern during construction as well as operation. During construction, discharge of oil and grease is most likely from workshops, oil and waste oil storage locations, and vehicle parking areas of the contractor and production floors. This is likely going to be minimal and there is plan in place to manage the oil during any aspect of the operation to avoid pollution. Any used oil generated shall be handled and disposed as per FMENV standards and guidelines. The location of all fuel storage and vehicle cleaning area will be at least 300m from the nearest drain.

Water Quality Monitoring

Apart from provision of the mitigation measures, water quality shall be monitored to understand the effectiveness and further improvement in designs in reducing the concentration of pollutants. The monitoring plan shall be functional in construction as well as in operation stages. The frequency, duration and responsibility will be as per the Environmental Monitoring Plan.

Noise levels

Environmental noise depends on factors such as traffic intensity, the type and condition of the vehicles plying on the area, machinery, and construction equipment. In the future years, the chances of increase in noise level is anticipated due to increase in traffic and number of employees and frequency of activities within the factory.

Impact:

During the construction phase of the project, the major sources of noise pollution are vehicles transporting the construction material to the site and the noise generating activities within the site. Mixing, casting and material movement are primary noise generating activities on site and will be uniformly distributed over the entire construction period. Construction activities are anticipated to produce noise levels in the range of 40 - 95 dB (A).

- The construction equipment will have high noise levels, which can affect the personnel operating the machines. Use of proper Personal Protective Equipment (PPE) such as earmuffs will mitigate any adverse impact of the noise generated by such equipment.
- The noise likely to be generated during excavation, loading and transportation of material will be in the range of 30 to 105 dB (A) and this will occur only when all equipment operates together and simultaneously. This is, however, a remote possibility.
- The workers in general are likely to be exposed to an equivalent noise level of 40 to 90 dB 8-hour's exposure per shift, for which all statutory precautions should be taken into consideration. However, careful planning of machinery selection, operations and scheduling of operations can reduce these levels.
- Uninterrupted movement of heavy and light vehicles may cause increase in ambient noise levels on the project area and its environs. It may have negative environmental impacts on the sensitive receptors close to the project area. Table below present the source of noise pollution and the impact categorization.

TABLE 6.4: SOURCE OF NOISE POLLUTION

S. No	Phase	Source of Noise Pollution	Impact Categorization
1.	Pre-Construction	▪ Man, material & machinery movements ▪ Establishment of labour camps onsite offices, stock	▪ All activities will last for a short duration and shall be localized in nature

S. No	Phase	Source of Noise Pollution	Impact Categorization
		yards and construction plants	
2.	Construction Phase	Construction site: Concrete mixing, diesel generators etc.	Impact will be not significant within 500m.
3.	Operation Phase	▪ Due to increase in traffic of vehicles to the location	Observation of speed limit that will reduce noise generated by trucks.

The impacts of noise due to the project will be of temporary localized within the construction phase.

6.5.10 Cultural Resources:

There is no such impact on cultural resources as such in the project location. The proposed project location has been designated as industrial hub by NCDMB and there are no identified cultural resources.

6.5.11 Biological Environment:

The principal impact on flora involves the removal of grasses (secondary afforestation).

6.5.12 Public health and safety

Impacts on public health and safety may arise during the phases of pre-construction, construction and operation phases but are located within the Industrial hub. During the pre-construction and construction phases, dismantling of the structures and construction activities may result in the following health hazards:

- Debris generated because the above-mentioned activities if not properly disposed might give rise to health problems within the industrial hub. However, the structures to be dismantled during pre-construction phase will mainly be of semi-permanent and temporary nature and much of the waste shall be salvageable.
- Labourers hired from outside can have clashes with the local labourers because cultural and religious differences. The influx of a large work force to an area, already hard pressed for basic services (medical services, power, water supply, etc.), can impose additional stress on these facilities. Since as per the baseline environmental condition a significant number of workers is marginal workers, the proponent may source these local labours during the construction period.
- Unsanitary conditions on site might also result in impact on health of labourers.

Transmission of diseases is also facilitated by the migration of people. During the construction phase work, crews and their dependents may bring with them a multitude of communicable diseases including Sexually Transmitted Diseases (STDs) like AIDS. This is more so if the nature of the project requires more male-workers, who have migrated from other parts of the state or country.

- During construction movement of raw materials into the Industrial hub may cause disruption of social and economic life of the indigene along the route & of the nearby areas.

Traffic Control during Construction

- The Industrial hub is well planned in such a way that control of traffic is excellent. The project area is not prone to public traffic and congestion; however, the project proponent will lash its plan on the existing traffic control within the project location.
- Temporary diversion where necessary will be constructed with the approval of the Engineer within the Industrial hub. Special consideration will be given in the preparation of the traffic control plan to the safety of pedestrians and workers at night.

6.5.13 Risks Associated

The project proponent is required to comply with all the precautions as required for the safety of the workmen during the project phases. The supply of all necessary safety appliances such as safety goggles, helmets, masks, etc., to the workers and staff is very compulsory. The project proponent should comply with all regulation regarding scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress.

Risk from Electrical Equipment

Adequate precautions will be taken to prevent danger from electrical equipment. No material or any of the sites will be so stacked or placed as to cause danger or inconvenience to any person or the public. All necessary fencing and lights will be provided to protect the public.

Risk at Hazardous Activity

All workers employed on mixing concrete material, cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles. Workers, who are engaged in welding works, would be provided with welder’s protective eye-shields.

Stonebreakers will be provided with protective goggles and clothing and will be seated at sufficiently safe intervals. The use of any toxic chemical will be handled strictly in accordance with the manufacturer's instructions. A register of all toxic chemicals delivered to the site will be kept and maintained up to date by the project proponent. The register will include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, handling and storage procedures, and emergency and first and procedures for the product.

Risk of Lead Pollution

No man below the age of 18 years and no woman will be employed on the work of painting with products containing lead in any form. No paint containing lead or lead products will be used except in the form of paste or readymade paint. Face masks will be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.

Risk caused by Force' Majeure

All reasonable precaution will be taken to prevent danger of the workers and the public from fire, flood, frowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during work.

Risk from Explosives

The construction workers will not use explosives except as may be provided in the contract or ordered or authorized by the Engineer. Where the use of explosives is so provided or ordered or authorized, the Contractor shall comply with the requirements.

First Aid/Medical facilities

At every workplace, a readily available first aid unit including an adequate supply of sterilised dressing material and appliances will be provided as per the Factories Act 2004. There will be provision of first aid and medical facilities. The project proponent shall subscribe to the Federal Government National Health Insurance Scheme (NHIS) for all employees.

Potable Water

The project proponent shall provide at suitable and easily accessible places a sufficient supply of potable water for all the employees.

Hygiene

There will be provision within the precincts of every workplace, conveniences in an accessible place, and the accommodation, separately for each for these, as per standards. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking, and washing. The sewage system for the site construction must be meticulously designed, built, and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses take place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins shall be provided in the project area and regularly emptied, and the garbage disposed of in a hygienic manner.

TABLE 6.5: ENVIRONMENTAL AND SOCIAL IMPACTS IN LINE WITH IFC PERFORMANCE STANDARDS

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
PS1: Social & Environmental Assessment & Management Systems	When local communities are affected by risks or adverse impacts from a project, the project proponent must ensure adequate engagement with the communities to build and maintain a constructive relationship over time. Project proponent should disclose project-related information to helps affected communities understand risks, impacts and opportunities of the project.	▪ Typically, construction works of this nature includes handling or generation of dust particles. The location of the project is within the NCDMB proposed industrial hub and it has a sufficient Right of Way or buffer zone. Thus, significant adverse environmental and related social impacts from the project on the local community are not envisaged. ▪ The project will provide employment opportunity. Rungas Prime Industries Limited has its own robust Social Environmental Health and Safety Management System (SEHSMS) under the requirement of IFC PS1 requisites. Applicable environmental management procedures need to be developed and implemented throughout the project life cycle as an integral part of Occupational Health & Safety Management System by	Low

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
		Rungas Prime Industries Limited.	
PS 2: Labour and Working Conditions	The project proponent should provide the workers with a safe and healthy work environment in accordance with applicable labour laws, considering inherent risks in its particular sector and specific classes of hazards in the client's work areas. The proponent should take steps to prevent accidents, injury, and diseases arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards. In a manner consistent with good international industry practice, the client will identify potential hazards to workers, particularly those that might be life-threatening; provide preventive and protective	▪ It is anticipated that so many contract workers are likely to be deployed for the proposed project during construction phase. Hence Rungas Prime Industries Limited as principal employer has obtained necessary registrations for the establishment in accordance with the provision of Nigerian Factories (Labour) Act 2004. ▪ All contract workers engaged by the project contractor onsite need to be provided with an employment identity card specifying the worker, contractor and principal employer name, nature of work, wage rate, wage period etc. Adequate surveillance of construction work areas and muster roll need to be undertaken by Rungas Prime Industries Limited to check for any deployment of child labour onsite which is prohibited under relevant provision of Child Labour (Prohibition and Regulation) Act.	Medium

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
	measures, including modification, substitution, or elimination of hazardous conditions or substances; train workers; document and report occupational accidents, diseases, and incidents; and be prepared for preventing and responding to emergencies. The proponent should also ensure that child labour is not availed at any stage of the project.	▪ During discussion with Rungas Prime Industries Limited, it is revealed that during construction phase, water will be provided by EPC contractor through water tanker. Rungas Prime Industries Limited shall also ensure that drinking water for labour and staff during construction and operational phase must be the drinking water criteria of Federal Ministry of Environment. ▪ Safety at work will have to be ensured during (a) manual excavation during construction (cut hazard), (b) manual loading and unloading of materials, (c) construction work of existing project having significant traffic movement, and (d) working on electrical equipment during repair and maintenance work (electrocution hazard). Taking into consideration the nature of activities expected during the operations phase, the only work-related emergency that seems likely is an outbreak of fire but the same should be controlled	

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
		with fire extinguishers to be maintained by Rungas Prime Industries Limited. ▪ The company will need to ensure the health and safety of workers as required by Bayelsa State Ministry of Environment/FME guidelines and International Construction Measures Rungas Prime Industries Limited to ensure proactive efforts are being made by the civil contractors towards provision of welfare facilities for contract workers viz. sufficient supply of drinking water,creches, latrines and urinals, washing facilities etc. In case the construction workers require temporary shelters at site during the construction period, the same will have to be managed as per the guideline published jointly by International Finance Corporation (IFC) and the European Bank for Reconstruction and Development (EBRD) and relevant provisions of the above-mentioned regulations. ▪ Rungas Prime Industries Limited need to	

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
		ensure that the contract workers are subjected to timely payment of minimum rates of wages in line with labour law. Further necessary records viz. register of fines, overtime, wages, wage slip, annual returns, etc. need to be maintained by the project contractor as per the aforesaid regulations. ▪ In line with the IFC PS requirements for development and implementation of EMS, Occupational Health and Safety Procedure and Worker Accommodation Guidelines including applicable national labour legislations need to be developed and implemented by Rungas Prime Industries Limited in different phases of the project life cycle. This includes provision of adequate PPEs by contractor to the workforce, supply of potable drinking water to contractor workforce, medical support, adequate sanitary facilities, rest room, kitchen etc. Further Rungas Prime Industries Limited	

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
		need to enhance awareness of the contractor workforce on occupational health and safety risks through implementation of training programme in accordance with OHS & EMS. ▪ Rungas Prime Industries Limited need to make incident reporting and investigation as integral to its OHS & EMS and the same has been communicated to the civil contractors.	
PS 3: Pollution Prevention & Abatement	The project proponent should ensure that adequate control techniques are provided to minimize emissions or achieve a pre-established performance level. The proponent should ensure that generation of hazardous wastes are minimized, and handling, storage and disposal are managed properly to prevent any adverse social and environmental impacts. Reasonable inquiry about the location of the final disposal of	• The proposed project location is mainly grasses that will not require tractors to clear the vegetation and as such the negative effects of release of dust will drastically be reduced to barest minimum. However, during constructional phase, fugitive dust generated due to excavation work and material handling can temporarily contribute to the ambient air pollutant load at the work site. Vehicular emissions may lead to increase in air pollutant levels in ambient air. Considering absence of any sensitive receptors and the fact that the	Low

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
	their waste, even if the disposal is conducted by the third party and especially if the waste is considered to be hazardous to human health and the environment should be carried out.	proposed project is within the Industrial hub and ambient air quality parameters well within the applicable national standards, impact of vehicular emissions and dust generation is not likely to cause any community health and/or environmental impacts. The increase in air pollutant concentration and noise levels caused by the proposed project during its constructional phase is expected to be short-lived and insignificant. ▪ Considering 80% of the total domestic water consumption being generated as waste water, very low volumes of sanitary waste water will be generated during temporary constructional phase and operation phases. The domestic wastewater needs to be managed through suitably designed septic tank-soakaway pit system. ▪ Rungas Prime Industries Limited will need to ensure oil used in Diesel Generating sets during the construction work is free of	

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
		Polychlorinated Bi-Phenyls. ▪ Hazardous wastes such as empty paint containers (generated for the marking, painting and signages during construction and operation, will be handled and disposed in a manner that contamination of soil or groundwater is prevented. ▪ During decommissioning phase, temporary impacts are envisaged. However, these impacts are likely to be short terms and localized in nature and can be mitigated through implementation of appropriate mitigation measures as outlined in the "Decommissioning Plan"	
PS 4: Community Health, Safety and Security	The project proponent should avoid or minimize risks to and impacts on the health and safety of the local community during the project life-cycle from both routine and non-routine circumstances. The proponent should also ensure that the safeguarding of personnel	▪ With limited emissions to air, proper drainage, sediment control, top soil conservation, noise barrier the threat to community health and safety is minimal. Septic tank-soak pit system, if not built with proper design, may contaminate the groundwater. Soil percolation capacity and depth in groundwater must be considered	Low

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
	and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security. The proponent should avoid or minimize the exacerbation of impacts caused by natural hazards, such as, landslides or floods that can arise from land use changes due to project activities.	during designing. Integrity testing is to be done during commissioning to ensure that groundwater is not polluted. ▪ Movement of heavy vehicles carrying materials and machines for a short period of time is not expected to disturb the local communities, provided that the locals are informed prior to beginning of such activities. The security personnel are planned to be locals employed from nearby villages. ▪ Workforce required during constructional phase will be sourced locally from nearby villages depending on their literacy levels and skill sets. Rungas Prime Industries Limited need to ensure that there is no conflict between the migrant workers and the local people, as this could adversely affect the reputation of the company. Individual or group protest against the project is not a likely scenario because of the non-polluting nature of the project and	

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
		positive perception of the locals about the company and the project as documented during the public consultation programme. However, Rungas Prime Industries Limited must be prepared for unforeseen emergencies such as an individual or group protest the project and the situation should be considered as an ‘emergency’. The company will have to be prepared for such an emergency situation, ensure adequate management measures to handle such an emergency in a way that the situation is controlled, and the construction work and workers are protected against damage. In this regard, the company need to develop and implement a community engagement and grievance management procedure to address any such potential conflicts and/or concerns.	

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
PS 5: Land Acquisition and Involuntary Resettlement	The project proponent should preferably acquire land for project by negotiated settlement and should avoid expropriation.	▪ The proposed location for the project was acquired from the NCDMB, which was designated as an Industrial development hub by NCDMB. ▪ There is no need for compensation to be paid as it was already settled by NCDMB during acquisition.	Low impact
PS 6: Biodiversity Conservation & Sustainable Natural Resource Management	The project proponent should protect and conserve biodiversity.	▪ There are no legally notified ecologically sensitive areas viz. National park, wildlife sanctuary etc. within the 10-km radius of the project site, therefore impacts on biodiversity are not expected due to the proposed project. However, clearing of vegetation will be involved.	Medium
PS 7: Indigenous People	The project proponent should minimize, mitigate, or compensate for adverse impacts on scheduled tribe and provide them opportunities for development benefits.	▪ Since there are no affected tribal communities, the Performance Standard is not applicable to the project.	No impact

(a) Title of Performance Standard (PS)	(b) Performance Standard requirements	(c) Assessment of potential risks and impacts	(d) Assessed risk
PS 8: Cultural Heritage	The project proponent should ensure there are no adverse impacts on the cultural heritage in the project area.	▪ No significant area or building of cultural heritage is present near the project site, hence no impact is envisaged here.	No impact

CHAPTER SEVEN

MITIGATION MEASURES

7.0 INTRODUCTION

The project proponents have the responsibilities to; avoid, minimize, and remedy adverse impacts; internalize the environmental and social costs of the proposal; prepare plans for managing impacts and repair or make compensation for environmental damages.

Impact management ensure mitigation measures are implemented to:

- establish systems and procedures to prevent such predicted impacts of any proposed project or cause of action
- monitor the effectiveness of mitigation measures

Mitigation measures ensure:

- initiation of action when unforeseen impacts occur
- better ways of doing things are sought
- enhancement of environmental and social benefits
- avoidance, minimize or remedy adverse impacts
- that residual impacts are within acceptable levels

The principles of mitigation measures are to:

- give preference to avoidance and prevention measures
- consider feasible alternatives to the proposal
- identify customized measures to minimize the major impact
- ensure they are appropriate and cost-effective
- use compensation as a last resort

7.1 Mitigation Measures/Plan

This chapter is dedicated to developing a mitigation measures to manage the identified and predicted impacts as stated in chapter six of this report as it concerns the project. Below is a detailed mitigation measures.

TABLE 7.0: MITIGATION PLAN FOR POTENTIAL IMPACTS

Potential Impacts	**Related Activity/ Sources**	**Mitigation Measures**
Gaseous emissions (CO_2, NO_2, SO_2 & CO), Particulates & hydrocarbons	Transportation of materials, plants and labour to site, operations involving the use of machinery; internal combustion from engines, occasional particulate release.	At the event of prolonged dry weather activities **Rungas Prime** shall spray water within the project location to moisten the soil and keep dust under control. In addition, workers will be provided with respiratory protective kits. • All fuel combustion engines shall be maintained at optimal operating conditions to reduce the emission of exhaust gases.
Hearing impairment, communication interference, & annoyance, work inefficiencies, psychological distress and other noise related health problems.	Construction activities, operations of machines/ engines, transportation, and excessive use of alarm systems.	• All machinery and equipment likely going to produce noise should be serviced and noise abatement facilities should be installed. • The use of earmuffs shall be enforced for all staff working in noisy areas or engaged in the use of high noise equipment/ machinery
Geology/hydrogeology/ Geomorphology Drainage/discharge, hydrological pattern, sedimentation,	Sand winning, barrier construction, excavations and other foundations.	• Waste pits shall be constructed to meet regulatory requirements for such facilities. • All boreholes shall be cased and sealed. • Construction to avoid introducing contaminants into the aquifer • **Rungas Prime** shall adopt the FMENV & Bayelsa State Min. of Environment recommended approach in the clean-up of any contaminated soil or groundwater. The approach involves location and isolation of site and recovery/clean up of site
Socio-Economics Community disturbance may result	Production	• This shall reduce the impact on present infrastructure. • Sustain the current open-door policy to facilitate flow of information to and from host communities.

		• Skill improvement training programme and youth vocational training shall be extended to all the host communities.
	Commencement of project and project implementation/ execution.	• Rungas Prime should diligently observe agreements reached with host communities. • Where practicable Rungas Prime Industries Limited should continue to sponsor health education campaigns and the hazards and risks to which the people may be exposed because of the project. • Rungas Prime shall aid the host communities in the area of hygiene • Rungas Prime shall assist in strengthening government's effort in capacity building towards health care delivery services in the host communities. • Rungas Prime shall ensure that all employees on the project undergo pre-employment and periodic medical examination.
Climatological Parameter The microclimate is likely to be temporarily modified by vegetation. There will be an increase in daytime temperature arising from some heat that will be generated from the factory and soil due to loss of shade and vegetation	Site clearing	• Green area and tree plantation shall be undertaken to conserve the affected species. Such tree plantation will restore the microclimate of the region.
Physiography & Land Use during Pre-construction and Construction Stage Project activities involve alterations in the local physiography and drainage patterns.	The impacts on physiography may include de-stabilization arising from slopes due to cut and fill operations.	• Appropriate embankments and culvert for erosion prone areas. • The soil has an angle of repose. Slope protection is normally required only for slopes. • Shrubs and grasses will be planted in sloppy area
Geology and Seismology During Pre-Construction,	Excavation and civil construction	• No negative seismological impact is anticipated on the

Construction and Operation Stage The seismic information of the state indicates that the project area is free of earthquake and do not have any such history. The project will not pose impact on geology and seismic condition.	activities	project. • However, all the structures and facilities/equipment should be constructed and installed considering the respective seismic information to obtain design safety.
Soil Erosion: Elevated sections particularly at high embankments would be vulnerable to erosion and need to be provided proper slope protection measures to prevent erosion.	Exposed sections of soil during clearing of vegetation	The project site is a sand-filled area and it is unlikely that there will be a detrimental removal of any topsoil. However, where it will be necessary, efforts shall be made to minimise the intake of productive lands. To conserve the productive topsoil the following measures have been proposed: • The topsoil from all areas of cutting and all areas to be permanently covered shall be stripped to a specified depth of 150mm and stored in stockpiles. At least 10% of the site shall be earmarked for storing topsoil. • The stockpile shall be designed such that the slope does not exceed 1:2 (vertical to horizontal), and the height of the pile be restricted to 2m. To retain soil and to allow percolation of water, silt fencing shall protect the edges of the pile. • The stockpiles shall be covered with gunny bags or tarpaulin. • Such stockpiled topsoil will be returned to cover the disturbed area and cut slopes
Soil Contamination during Construction Stage. Contamination of soil during construction phase	Contamination of soil during construction stage	**Construction debris:** • To be stored safely and managed by

is primarily due to construction and allied activities mostly from the construction area		Bayelsa State Ministry of environment approved waste vendor **Soil Contamination due to accidental spills:** • An emergency response team to be created to clean up any spill. **Soil contamination due to run off** • Improvements of design shall lead to less accidents and hence less spillage of oil and grease • Fuel storage will be in proper bounded areas. • All spills and collected petroleum products to be disposed of in accordance with guidelines of FMENV and as per the directions of the Emergency Response team. • Fuel storage and fuelling areas will be located at least 300m from all cross-drainage structures and significant water bodies
Noise Impact	All construction equipment, plants, machinery and vehicles will follow prescribed noise standards.	• All construction equipment used for an 8-hour shift shall conform to a standard of less than 85dB (A). • Vehicles and construction machinery shall be monitored regularly with attention to silencers and mufflers to maintain noise levels to minimum. • Workers near high noise area must wear ear plugs, hardhats and should be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 85dB (A) per 8-hour shift.

THE SUMMARY OF MITIGATION MEASURES FOR IMPACTS ON AIR QUALITY

TABLE 7.1: SUMMARY OF MITIGATIONS FOR IMPACTS ON AIR QUALITY

S/ N	Description	Impact	Reason	Mitigation / Enhancement
1.	Meteorological factors and climate	Marginal impact	Due to production and machinery operation	▪ Comprehensive afforestation ▪ Avenue plantation ▪ Shrub plantation in the median / island
2.	Dust generation	Temporary & location specific	Shifting of utilities, removal of trees & vegetation, transportation of material	▪ Sprinkling of Water ▪ Fine materials to be completely covered, during transport and stocking. ▪ Plant to be installed in down wind direction from nearby settlement.
3.	Gaseous pollutants	Moderate impact	Clearing and excavating materials & clearing of the surface	▪ Air pollution monitoring plan will be enforced ▪ Workers will be provided protective kits. ▪ Local people will be educated on safety and precaution.
4.	Air quality emissions	Moderate impact	Air pollutants from traffic	▪ Compliance with future statuary regulatory requirements
5.	Air quality monitoring		Effectiveness shortfall of any unforeseen impact	▪ Measures will be revised & improved to mitigate impact

TABLE 7.2: MITIGATIVE MEASURES, MONITORING ACTIONS AFFECTING ENVIRONMENTAL RESOURCES AND HUMAN AMENITY.

Action	Potential impact	Mitigation Measures	Responsibilities
A. During Maintenance & Construction			
Excavation and earth movement	Dust emission	• Wetting excavated surfaces • Using temporary windbreaks • Covering truck loads	Maintenance Manager
	Noise generation	• Restriction of vehicular movement hours to daytime • Employing low noise equipment proper maintenance of equipment & vehicles, & tuning of engines and mufflers	Maintenance Manager/Envi. Manager
	Erosion	• Proper resurfacing of exposed Areas • Inducing vegetation growth	Maintenance Manager
	Disturbance to biodiversity	• Conservation of present vegetation and used as wind brakes and aesthetic cover for the facility. • Inducing vegetation growth	Maintenance Manager
Dumping of excavated and construction material into the environment	Groundwater pollution	• There will be prohibition of uncontrolled dumping in any phase of the project. Disposal at appropriate dumpsite. • Awareness creation amongst workers on environmental protection	Environmental Manager
Discharge of wastes (Chemicals, oïl, lubricants, etc.) on-site	Soil and water pollution	• Prohibition of uncontrolled discharge. Proper disposal of hazardous product. • Education of workers on environmental protection	Environmental Manager
Storage of hazardous	Hazards to	• Proper supervision for high workmanship performance	Environmental Manager

material, traffic deviation, deep excavation, movement of heavy vehicles, etc.	public and occupational safety	• Provision of adequate safety measures, and implementation of health and safety standards	
B. During Design; Operation & production			
Inadequate process design and control	Generation of design engineer's obnoxious odours	• Improving operation & maintenance design procedures • Provision of covers where possible • Landscaping a proper natural windbreaker around the facility • Maintenance of leachate collection Containers • Maintaining proper cleanliness and housekeeping • Transportation of odorous by-products in enclosed container trucks	Design Engineer
	Impaired aesthetics	• Maintaining cleanliness around and within the plant • Proper fencing and landscaping	Plant Manager
	Noise generation	• Limit product collection and delivery of raw materials to daytime hours • Incorporating low-noise equipment • Locating mechanical equipment in proper acoustically lined enclosures • Proper fencing and landscaping	,,
	Traffic generation	• Proper routing of material delivery trucks • Limiting product collection and delivery to daytime hours	,,
		• Restricting unattended public	

	Public & occupational hazards	access • Providing adequate safety measures and monitoring equipment • Emphasizing safety education and training for system staff Implementing health and safety standards	HSE Manager
Inappropriate waste collection	Accumulation of waste at waste collection bins	• Create and monitor waste collection schedules	HSE Manager
Inappropriate equipment maintenance operations	Noise pollution and breakdown of equipment	• Regular maintenance culture	Plant Engineer.
	Incurred additional cost by machinery replacement		

TABLE 7.3 IMPACTS ON WATER RESOURCES DURING THE CONSTRUCTION STAGE

S/N	Item	Impact	Impact (Reason)	Mitigation / Enhancement
1.	Loss of water bodies	Major, direct impact	Part or complete acquisition of source of water	▪ Land acquisition has been done in line with Bayelsa State Govt. approval of the location for NCDMB and has been designated for industrial hub. ▪ There is likely not going to be negative impact that will warrant loss of water body as embarkment shall be done at the bank of the Taylor Creek
2.	Runoff and drainage	Direct Impact	Siltation of water bodies Reduction in ground recharge Increased drainage discharge	▪ Silt fencing to be provided where applicable. ▪ Continuous drain is provided
3.	Water requirement for project	Direct impact	Water requirement for construction & operation activity. Water requirement for labour	▪ Construction workers shall minimise water usage ▪ Avoidance of depletion of water sources.
4.	Increased sedimentation	Direct impact	Increased sediment laden run-off after the nature and capacity of the watercourse	▪ Silt fencing to be provided
5.	Contamination of Water	Direct adverse impact	Oil and diesel spills Routine and periodical maintenance	▪ Hazardous wastes Management and handling to be done as per the IFC & FMENV guidelines ▪ Oil Interceptor will be provided for accidental spill of oil and diesel. ▪ Septic tank will be construction for waste disposal.
6.	Water quality monitoring		Effectiveness / shortfall (if any) Any unforeseen impact	▪ Measures will be revised and improved to mitigate / enhance environment due to any unforeseen impact.

7.2 CONTINGENCY PLAN

The contingency plan in case of emergency was tackled in the design consideration of the facility. The production hall during operation phase will be hot but there is an adequate ventilation plan & installation of heat extractors and industrial fans in place. This zone shall be equipped with blowers to ensure proper aeration. Emergency evacuation plan shall be put in place to ensure that personnel and visitors to the factory are not trapped. These preventive measures and design considerations will ensure a continuous and uninterrupted operation in the facility.

The following emergency/contingency plans should be in place:

- Installation of fire suppression system for computer/control rooms
- Design of emergency evacuation routes and safety signs should be in place to ensure easy evacuation.
- Educate workforce and visitors on the emergency preparedness within the factory
- Constitute an in-house emergency committee to manage any emergency
- Integrate the community and government bodies in your emergency response plan.
- Install secondary containment for all hazardous chemicals and by-products to avoid spill and loss of containment.
- Regular inspection on the contingency management system.
- Train staff and visitors who may be affected in case of an emergency on the emergency plan of the proposed Type 3 Composite LPG Cylinder manufacturing plant.
- There shall be good access in any case of emergency.
- Installation of CCTV cameras to aid security measures

CHAPTER EIGHT

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.0 INTRODUCTION

The Environmental and Social Management Action Plan (ESMP) is a remedial action plan required to ensure sustainable development of the project during construction and operational phases. It is a concise framework initiated to curb the identified negative impacts of the proposed project. The ESMP is drawn to be location, activity, and time specific. In general, Federal Ministry of Environment is the ministry responsible for enforcement of environmental mitigation measures. Mitigation measures for generic impacts are listed in **Table 8.1**. The list provides implementing organisation and responsible entity.

8.1 SITE SPECIFIC MANAGEMENT PLAN

8.1.1 Cultural Properties

The project is within the Industrial hub and there is no impact on cultural property (e.g. temple, mosque etc.).

8.1.2 Sensitive Features

Noise barriers in the form of compound walls have been proposed where there is the tendency for excessive noise that may jeopardise the peace of people that may be affected by construction activities.

8.1.3 Community Properties

There is no community property that would be affected during construction or production phases since the proposed location is within the Industrial hub.

8.2 IMPLEMENTATION OF ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental Officer should be available for the entire duration of the project construction phase and production phases. The Environmental Officer shall primarily be responsible for compliance with the ESMP. The Environmental Specialist shall monitor the compliance of the ESMP. The key issues that require special attention along with the mitigations to be implemented have been detailed in Table 8.1.

TABLE 8.0: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

Environmental Impact / Aspect	Mitigation Measures	Location	Time Frame	Responsibility		Cross reference
				Implementation	Supervision	
DESIGN STAGE						
Geometric Design	The proposed alignment is selected / adjusted: • to minimise land disturbance and impact on structures • to avoid culturally & environmentally sensitive areas – cultural properties, water bodies, schools, hospitals etc.		During alignment Design	Rungas Prime Industries Limited / contractor	FMENV	
Issues from stakeholder Consultations	Various issues raised were examined & suitably incorporated based on merit & other project safety measures. Further input if any come out from public review will be incorporated in the final ESIA report		During Design	Rungas Prime Industries Limited / civil contractor	Rungas Prime/ FMENV	
Orientation of Implementation Team	A comprehensive training / orientation schedule has been prepared at different stages.		During Design	Rungas Prime Industries Limited	FMENV	
PRE-CONSTRUCTION STAGE						
Land Acquisition	Land requirement details to be sent to the Govt. and permission to be taken for the same.	N/A	N/A	Rungas Prime Industries Limited	FMENV	

Mobilisation & Site Clearance						
Forest Approval	The Bayelsa State Government approved the area as Industrial hub and as such approvals to develop the area as industrial hub was given by the Bayelsa State Government/ NCDMB.		Before construction Starts & after centre line marking at site	N/A	FMENV	
Removal of Vegetation	Vegetation will be removed from the worksite before the commencement of Construction	Project location	Before construction Starts and after centre line marking at site	Rungas Prime / Contractor	FMENV	Forest Approval
Procurement of Batching Plants, other Construction Vehicles, Equipment & Machinery	Specifications of machinery, batching plants, and other Construction Vehicles, and Equipment to be procured will comply with the requirements of the relevant current emission control legislations in Nigeria as directed by FMENV/ Bayelsa State Min. of Environment		Prior to mobilisation at site	Rungas Prime Industries Limited/ Contractors	FMENV	Procurement Document and Technical Specification provided by the plant operator
Setting up of construction Offices/camps	The construction camps will be located far away from habitations & sensitive locations The Civil Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation, offices and ancillary facilities for labour to standards and scales approved by the	All areas in immediate vicinity of construction campsite chosen by the Concessionaire / Contractor and approved by the Project Engineer	During Establishment, Operation and Dismantling of Such Camps.	Rungas Prime Industries Limited / Contractor	FMENV	

	Project Engineer.					
Setting up of equipment	Machinery and batching plants shall be located far away from the nearest habitation. The Civil Contractor shall obtain the consent to operate the plants from Bayelsa State Ministry of Environment.	All heavy equipment & Batching Plants	During erection, testing, operation and dismantling of such plants	Rungas Prime Industries Limited	FMENV	Guidelines of FMENV & Bayelsa State Min. of Environment on obtaining license for establishing such plant and machineries
Identification of dumping sites	Location of dumping sites shall be finalized based on the FMENV & Bayelsa State Min. of Environment guidelines shall certify that: • These are not located within designated forest areas. • The dumping does not impact natural drainage courses •	Throughout the corridor	During mobilisation	Rungas Prime Industries Limited/ Contractor	FMENV	
CONSTRUCTION STAGE						
Clearances & approvals	Relevant permits and clearance in line with Industrial hub/ Environmental Guidelines should be obtained. • Adhere to all clearance terms and conditions		Construction stage (Prior to initiation of any work).	FMENV	Rungas Prime Industries Limited	General Conditions of Contract
Land						
Soil Erosion and Sedimentation	Main reason of soil erosion is rains. The project proponent shall plan the activities so that no naked / loose	Throughout Project Corridor, Service projects	Upon completion of construction	Rungas Prime Industries	FMENV	Standard engineering practices,

control	earth surface is left out before the onset of monsoon, for minimising the soil erosion following preventive measures to be taken such as: • Embankment slopes to be covered, soon after completion. • Next layer / activity to be planted, soon after completion of clearing and grubbing, laying of embankment layer, sub-grade layer, sub-base layer, scarification etc. • Top soil from construction site to be protected / covered for soil erosion. • Debris due to excavation of foundation, dismantling of existing cross drainage structure will be removed from the water course immediately.	and equipment storage sites, etc.	activities at these sites. During construction	Limited / Civil Contractor		
Loss of agricultural top soil	The vegetation of the Industrial hub has been cleared by NCDMB before acquisition by project proponent.	Project area	During construction	Rungas Prime Industries Limited / Civil Contractor	FMENV	Standard Engineering & Environmental Practices
Compaction of Soil and Damage to Vegetation	• All construction works & vehicles shall be operated within the area designated for the factory to avoid damage to soil and secondary vegetation.	Project area	During construction	Rungas Prime Industries Limited / Contractor	FMENV	

	• While operating on temporarily acquired agricultural land for any construction activities, top soil will be preserved in stockpiles.					
Contamination of soil	• Vehicle/machinery and equipment operation, maintenance and refuelling shall be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground. An "oil interceptor" will be provided for wash down and refuelling areas where applicable. • Fuel storage area shall be protected with bund walls. All spills and collected petroleum products shall be disposed of in accordance with Bayelsa State Min. of Environment /FMENV guidelines at designated locations. • Oil interceptor will be installed at construction site. • Septic tank will be constructed for safe disposal of waste.	At fuel storage areas – usually at construction camps, temporarily acquired site.	During Construction.	Rungas Prime Industries Limited/Civil Contractor	FMENV	
1. Material sources	• Sand shall be sourced from approved and licensed vendors • Adequate safety precautions shall be in place to ensure safe transportation of raw material from		During construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	

	quarries to the construction site. Vehicles transporting the material shall be covered to prevent spillage.					
Air					FMENV	
Dust Generation	• Vehicles delivering materials should be covered to reduce spills and dust blowing off the load. • Clearing and excavation to be done, just before the start of next activity on that site. • Civil contractor shall take every precaution to reduce the level of dust emission. • Plants, machinery, and equipment shall be so handled (including dismantling) as to minimise generation of dust. • Provision of breathing apparatus shall be made and issued to employees working in a dusty environment	Work site	Beginning with & throughout construction.	Rungas Prime Industries Limited/Civil Contractor	FMENV	
Equipment Selection, Maintenance & operation	• Regularly conduct checks on construction vehicles to prevent pollution.	Work site	During Construction.	Rungas Prime Industries Limited/Civil Contractor	FMENV	
Pollution from Machinery	• All machines to be used in construction shall conform to	All machines	During Erection, Testing,	Rungas Prime	FMENV	

	relevant dust emission control legislations. • Water will be sprayed during the non-monsoon months, regularly to minimize dust, in the whole crusher plant area.		Operation and Dismantling of such plants.	Industries Limited/Civil Contractor		

Water						
Water requirement for project	• During construction, the existing borehole will be used. • Civil contractor will ensure optimum use of water; discourage labour from wastage of water.	Throughout Project area, all access projects, temporarily acquired sites.	During Construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	
Silting / sedimentation	• Measures suggested under "Soil Erosion and Sedimentation control" will be enforced. • Silt fencing is provided around water bodies. • Where silting will result, construction activities will be stopped near water bodies during monsoon. No surface water is close to the project site		Throughout construction period	Rungas Prime /Civil Contractor	FMENV	
Contamination of water	• Measures suggested under "Contamination of soil" will be enforced. • Car washing / workshops near water bodies will be avoided.	All areas in immediate vicinity of construction campsite chosen by the civil Contractor.	Throughout construction period, installation and dismantling of temporary structure for site workers.	Rungas Prime Industries Limited/Civil Contractor	FMENV	
NOISE						
Noise from Vehicles, Plants and Equipment	• Noise standard at construction sites, e.g. batching plant, furnace plant will be strictly monitored to prevent exceeding noise standards. • Workers in vicinity of loud noise,	Production floor, sites	Throughout construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	

	and workers working with or in crushing, compaction, concrete mixing operations shall wear earplugs and their working time should be limited as a safety measure. • Machinery and vehicles will be maintained to keep their noise to a minimum. • Construction of noise barriers at sensitive receptors. • All vehicles and equipment used in construction shall be fitted with exhaust silencers. During routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found to be defective shall be replaced.					
FLORA & FAUNA						
Loss of trees and Avenue Planting	• Where necessary excessive clearing of vegetation shall be avoided.		After completion of construction activities	Rungas Prime Industries Limited/Civil Contractor	FMENV	
Vegetation clearance	• Clearing and excavation should be avoided beyond that which is directly required for construction activities. • Next activity to be planned / started immediately, to avoid dust generation and soil erosion during monsoon.		During cleaning operations. During construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	

	• Re-vegetation should be done where necessary.					
Fauna	• Construction workers must protect natural resources and wild animals. • Hunting will be prohibited. • Nesting grounds & migratory paths will be protected.		During construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	
SOCIO – ECONOMIC ENVIRONMENT						
Public Health and Safety	Debris generated will be disposed to the satisfaction in compliance with best practice. Monitoring of air, water, noise and land during construction and operational phase.		During Construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	
Accidents	The Civil Contractor should provide, erect and maintain barricades, including signs marking flats, lights and flagmen where necessary.		During Construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	
Temporary Loss of Access	The works shall not interfere with or cause inconvenience to public or restrict the access to use and occupation of public or private projects, and any other access footpaths to or of properties whether public or private.	Within Project location	During Construction	Rungas Prime Industries Limited/Civil Contractor	FMENV	
Project Safety & Construction Safety						
Traffic Delays	• There is an existing detailed Traffic	Within the	During	Rungas	Rungas	

& Congestion	Control Plan within the Industrial hub. The traffic control plans shall contain details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day. • Traffic congestion is not envisaged in the project area, but adequate arrangement should be in place.	project site	Construction	Prime Industries Limited/Civil Contractor	Prime Industries Limited	
Risk from Operations	• The Civil Contractor is required to comply with all the precautions as required for the safety of the workmen. • The Civil Contractor shall supply all necessary safety appliances such as safety goggles, helmets, masks, etc., to the workers and staff. • The Civil Contractor should comply with all regulation regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress. • No child labour shall be utilized in the project	Entire Project site.	During Construction	Rungas Prime Industries Limited/Civil Contractor	Rungas Prime Industries Ltd	
Risk from Electrical Equipment	• Adequate precautions should be taken to prevent danger from electrical equipment. • No material or any of the sites will	Entire Project site.	During Construction	Rungas Prime Industries Limited/Civil	Rungas Prime Industries Limited	

	be so stacked or placed as to cause danger or inconvenience to any person or the public. • All necessary fencing and lights will be provided to protect the public. • All machines to be used in the construction will conform to the relevant Electrical codes, will be free from defect, will be kept in good working order, will be regularly inspected, and properly maintained as per provisions.			Contractor		
Risk at Hazardous Activity	• All workers employed on mixing asphaltic material, cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles. • Workers, who are engaged in welding works, would be provided with welder's protective eye-shields. Stonebreakers will be provided with protective goggles and clothing and will be seated at sufficiently safe intervals. • The use of any toxic chemical shall be strictly in accordance with the manufacturer's instructions. A register of all toxic chemicals delivered to the site shall be kept and maintained up	Entire Project site.	During Construction	Rungas Prime Industries Limited/Civil Contractor	Rungas Prime Industries Limited	

	to date by the Civil Contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product.					
Risk caused by Force' Majure	All reasonable precaution will be taken to prevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during work.	Entire Project site	During Construction	Rungas Prime /Contractor	FMENV	
First Aid	• At every workplace, a readily available first aid unit including an adequate supply of sterilised dressing material and appliances will be provided as per the Factory Act. • Suitable transport will be provided to facilitate take injured or ill person(s) to the nearest applicable hospital.	Entire Project site.	During Construction	Rungas Prime / Contractor	FMENV	
Safety Measures During Construction	• All relevant provisions of the Factories Act, 2004 and • Adequate safety measures for workers during handling of materials at site will be taken up.	All construction sites	During construction	Rungas Prime/ Contractor	Rungas Prime	

	• The register will include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product.					
Hygiene	• Conveniences shall be provided with septic tank. The effluents can be diverted for horticulture inside the camps. • All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. • Garbage bins must be provided in the camps and regularly emptied and the garbage disposed of in a hygienic manner. • Adequate health care is to be provided for the work force. Unless otherwise arranged for by the local sanitary authority, the local medical health or municipal authorities. • On completion of the works, all such temporary structures shall be cleared away, all rubbish burnt, septic tank and other disposal pits filled in and	All Worker's Camps	During construction	Rungas Prime /Contractor	FMEnv	

	effectively sealed off and the outline site left clean and tidy, at the Concessionaire/ Contractor's expense, to the entire satisfaction of the Independent Engineer.					
Clearing of Construction of Camps & Restoration	Civil Contractor to prepare site restoration plans. On completion of the works, all temporary structures will be cleared away, all rubbish burnt, excreta or other disposal pits or trenches filled in and effectively sealed off and the site left clean and tidy. Where applicable residual topsoil will be distributed on adjoining / proximate barren.	Project location		RUNGAS PRIME INDUSTRIES LIMITED/Contractor	FMENV	
Monitoring at critical locations	The monitoring of Air, water and Noise to be carried out identified critical locations besides locations identified by along the project corridor.			Rungas Prime /Contractor	FMENV	
OPERATION STAGE						
Water quality degradation due to surface run-off	Silt fencing, Oil & Grease traps, etc. shall be provided at sensitive areas to ensure that the water quality is not impaired due to contaminants from project run-off. Monitoring shall be carried out as specified in the Monitoring plan	At sensitive water bodies identified. As specified in the monitoring plan	During Operational Stage	Rungas Prime /Contractor	FMENV	

Contamination of Soil & Water Resources from Spills	• Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals. • Spill of oil, fuel and automobile servicing units without adequate disposal systems in place to be discouraged. • Accidental spills are potentially disastrous, but its probability is quite low as one of the objectives of this project is to enhance project safety. • The Public will be informed about the regulations on land pollution. • Land pollution monitoring program has been devised for checking pollution level and suggesting remedial measures.	Entire Project	During Operational Stage	Rungas Prime /Contractor	FMEnv	
Traffic and Accident within Industrial hub	• Depending on the level of congestion and traffic hazards, traffic management plans will be prepared. • Traffic control measures including speed limits to be enforced strictly.	All along the Project corridor and surrounding areas.	During Operational Stage	Rungas Prime /Contractor	Rungas Prime	Throughout Operation/production Stage.
Accidents involving Hazardous Materials	• Creation of an Emergency Response team • For delivery of hazardous substances, permit license, driving license and guidance license will be required. • In case of spill of hazardous	All along the Project corridor and surrounding areas	During Operational Stage	Rungas Prime /Contractor	FMENV	

	materials, the relevant departments will be intimated at once to deal with it with the spill contingency plan.					
Monitoring at critical locations	The monitoring of Air, land, water and Noise to be carried out	Factory	Monthly and report quarterly to FMENV.	Rungas Prime /Contractor	FMENV	
Noise	• Horn Prohibited signpost will be enforced at strategic locations • Maintenance of noise barriers	Construction/operation phases.	During Operational Stage	Rungas Prime /Contractor	FMENV	

8.3 ENVIRONMENTAL MONITORING PROGRAM

The Environmental Monitoring Programme has been detailed as a stand-alone document. Successful implementation of the Environmental Monitoring Program is contingent on the following:

- The Project Proponent shall ensure compliance with the environmental monitoring plan.
- Submission of quarterly air quality and wastewater monitoring results to FMENV and Bayelsa State Ministry of Environment

Monitoring of Earthworks Activities

Most of the environmental problems related to the construction works are anticipated to be associated with the earthworks, particularly for the excavations. Other environmental effects associated with the earthworks include the development of adequate temporary drainage to minimise detrimental effects (e.g. erosion) due to run-off, and safety aspects related to Works implementation.

8.3.1Monitoring of Construction Facilities, Plant and Equipment

All issues related to negative environmental impacts of the construction facilities, Plant and Equipment are to be controlled through:

- Compliance with self-imposed quality assurance plan by project proponent and construction personnel on site;
- Regular / periodic inspection of the Site construction & Contractor’s plant and equipment
- Regular appraisal of the construction works / Contractor.

Other environmental impacts are to be regularly identified and noted on the monthly appraisal inspection made to review all aspects of the Civil Contractor's operation. The responsible officer is to review all monthly appraisal reports, and to rectify all significant negative environmental impacts.

TABLE 8.1 MONITORING PROGRAMME FOR THE RUNGAS PRIME INDUSTRIES LIMITED MANUFACTURING PLANT

S/N	Parameters	Key Performance Indicators (KPIs)	Frequency	Time frame for monitoring	Use
1	Soil quality	Soil samples should be collected within the factory to determine the following as a minimum against the baseline data: - pH values - Organic Carbon - Heavy metals	Annually	Throughout the lifespan of the production factory	- Internal Monitoring
2	Vegetation status & improvement	- Diversity - Morphology - Pathology	Bi- annually	Long term	-Compliance Purpose - Preservation of the vegetation
3	Ground water quality monitoring	- pH - TDS - TSS - BOD, COD - Turbidity; Etc.	Quarterly	Short term	- Internal monitoring -Send report to FMENV
4	Air Quality Monitoring	- Noise level - Total suspended solid (TSS) - Ambient air quality - Gaseous emission	Quarterly	short term	- Internal monitoring -Send report to FMENV
5	Contingency Management	- Awareness on the plan - Compliance with evacuation plan - Practical exercises (Drills)	Monthly	Long term	- Internal monitoring
6	Environmental	Environmental compliance	2Years	Long-term	EAR to be sent to

	Audit & Report (EAR)	monitoring			FMENV/Bayelsa State Ministry of Environment
7	Liquid Effluent	Treat effluent water to meet regulatory standards & analyse	Monthly	short term	Internal use and send reports to FMENV on quarterly basis.

8.4 IMPLEMENTATION AND MONITORING

This section provides an assessment of the existing institutional arrangement within Federal Ministry of Environment, the state Government and, reflects on capacity building / training issues that need to be addressed to ensure timely implementation of ESMP. The institutional arrangement proposed for this project has been presented here with newly defined roles and responsibilities. The responsibility of implementing the mitigation measures lies with the project proponent and the Federal Ministry of Environment. Rungas Prime Industries Limited will be responsible for planning all Environmental & Social Management Plan (ESMP) activities. In the pre-construction phase of the project Rungas Prime Industries Limited civil contractor shall study the ESMP to identify environmental issues and arrive at a suitable strategy for implementation.

8.5 ENVIRONMENT AND SOCIAL MONITORING/ FMENV/ BAYELSA STATE MINISTRY OF ENVIRONMENT

The Federal Ministry of Environment has an institutional capacity to meet the requirements for implementation of the environmental mitigation measures in the ESMP. As part of the project it is envisaged that they will continue to:

- Monitor progress of the implementation of the ESMP measures in consonance with the timeline for the project;
- Maintain interaction with the various statutory bodies;
- Interact with the Environmental Expert / the Environmental Consultants on the state of the environment and mitigation and enhancement measures adopted;
- Occasionally inspect the environmental measures being implemented by the Contractor;
- Report progress of works, both in terms of physical progress and quality for transmission to statutory authorities such as the Ministry of Environment;
- Document and disseminate good practices, bottlenecks, and their resolution during the implementation of environmental measures.

8.6 IMPLEMENTATION ARRANGEMENTS

The Management of Rungas Prime Industries Limited is responsible for the implementation of the provisions made within the ESMP through its site offices. The services of the Environmental Consultant will be procured to assist the site offices for monitoring the environmental aspects of the project during implementation. The organization chart for implementation arrangements.

8.7 CONTRACTOR

Execution of works will be the responsibility of the contractor and the management of Rungas Prime Industries Limited (Proponent). Every plan shall be complied with to ensure that the environment is always protected.

8.8 REPORTING SYSTEM

Reporting system provides necessary feedback for project management to ensure quality of the works and that the program is on schedule. The rationale for a reporting system is based on accountability to ensure that the measures proposed as part of the Environmental Management Plan get implemented in the project. Reporting system for the suggested monitoring program operates at two levels as:

- Reporting for environmental condition indicators and environmental management indicators
- Reporting for operational performance indicators at the Rungas Prime Industries Limited at their site level.

The reporting system will operate linearly – contractor who is at the lowest rung of the implementation system reporting, shall report to the Management of Rungas Prime Industries Limited. The Rungas Prime Industries Limited's site office will be responsible for setting the targets for the various activities anticipated during construction phase in consultation with the site Engineer and obtaining agreement from the Contractor after mobilisation but before beginning of works on site. The contractor will report from then on regarding the status on each of these.

8.9 ENVIRONMENTAL CAPACITY BUILDING

The project proponent has skill acquisition and training programs at different levels to equip her personnel on the efficient operation of equipment, safety and administrative aspects of the operation. Some short-term training is required for the Environment Manager, other staff members of the Environment Unit and the contractor staff to raise their levels of environmental awareness. The training can be conducted by either some external agency or through the help of in-house expertise of the consultants. In the long-term training, special environmental issues will be examined, and likely solutions provided to the Environment Department. The focus of future training programmes should be on implementation with special emphasis on the environmental protection. Identification of candidate locations for siting construction camps, disposal of excess cut material would be a priority in the short term.

The proposed training should also allow the officials to enhance their skills for effective monitoring of project by understanding the formats developed for reporting. In addition, close interaction is required among members of the project proponent and contractor responsible for the Environmental since it is envisaged that the two aspects will have a considerable overlap. It is envisaged that the training as part of the project include training on several issues important for both teams simultaneously.

8.10 DECOMMISSIONING & REMEDIATION PLAN

Everything on earth has a lifespan so also developmental project and when the project proponent decides in the future that the facility is no longer needed and wants to do away with it, the proponent is required to conduct a decommissioning plan for the equipment and reinstating the environment to a usable form. The plant is designed to last minimum of hundred (100) years and in case the plant will be shut down, the site will progress through decommissioning, remediation, and redevelopment. Though it is not always possible, it helps to know site reuse options early in the process to inform clean-up decisions and determine the appropriate level of work needed in each stage of the assessment, clean-up, and redevelopment process. Understanding the range of reuse options and needs associated with each will help in the development of realistic schedules and cost estimates. Time and costs associated with permits, approvals (of permits, plans, funding) and public involvement is factored into redevelopment plans as well. Decommissioning begins with an announcement that the plant is closing and ends when operations completely cease.

The Management of Rungas Prime Industries Limited shall develop a strategy for managing the decommissioning process that serves his or her business needs. A wide range of management strategies may be considered, from the proponent maintaining full control, to the selection of a third party to oversee the process. The proponent also may sell the property to a developer or municipality early in the process. During decommissioning, the electrical generating units shall be shut down and all operating permits are terminated. Any unused and hazardous materials associated with both the production process and the buildings/structures (e.g., process chemicals in the building or in equipment,) are removed. Production equipment is cleaned and may be removed for use at other locations or sold as scrap. Some demolition of buildings/structures may be performed to facilitate cleaning or equipment removal.

Remediation shall start with collection of soil and ground water samples to investigate and document any contamination. Next, a plan for clean-up is developed and once approved by FMENV & Bayelsa State Ministry of Environment. The Proponent shall develop a detailed decommissioning plant and environmental assessment of the area if the factory will be shut down.

8.10.1 OBJECTIVES OF DECOMMISSIONING AND ABADONMENT

There are basic objectives for developing a decommissioning and abandonment Plan for the proposed Type 3 Composite LPG Cylinder manufacturing Plant, which includes:

- developing a plan to remediate and minimize negative impacts on the precinct environment;

- ensures that the removal of equipment and machinery are done with utmost regards to the environment.

8.10.2 PURPOSE FOR THE DECOMMISSIONING GUIDELINES FOR DEVELOPMENTAL PROJECTS

The purpose of this guideline amongst others is to:

- provide clear directions and guidance on the step by step process involved in decommissioning a facility in Nigeria.
- aid in achieving an effective and environmentally sustainable decommissioning process that shall be compatible with intended future land use on health concerns and environmental impacts.

8.10.3 BASIC REQUIREMENT FOR A DECOMMISSIONING ACTIVITY

Decommissioning requirements expected of any facility is to provide acceptable standards required for eliminating environmental and health hazards during decommissioning and site clean-up. These requirements are applicable to development of decommissioning plan in line with regulatory authorities' framework on human health and environmental safety. The following strategies have been adopted by Rungas Prime Industries Limited:

- removal of structures on or beneath the ground,
- disposal or secure isolation and/or treatment of contaminated equipment in-situ or off-site,
- remediation of aesthetics (back-fillings, stained soil removal, waste disposals, etc.) and containment control of contaminant and general site clean-up.
- access controls for physical structures remaining on- site that are unsafe or hazardous to humans or animals
- remediation of aesthetically unacceptable portions of the site (filling of pits, removal of stained soil and odourous material, levelling of mounds, disposal of waste rock) etc.
- clean-up of the site to a level which will provide long-term environmental protection and will be safe for the intended future use
- registration on title to the property of any contaminants, wastes or structures left on site that restricts future land use or that require periodic monitoring to ensure continued integrity
- submission to the applicable regulatory agency and other required jurisdictions of a report confirming that decommissioning and clean-up has been completed

8.10.4 DECOMMISSIONING AND ABADONMENT OPTIONS

Two basic options are available when considering the decommissioning and abandonment of any facility. It can either be leaving the facility and removal of the facility. The two options have their own inherent advantages and disadvantages.

OPTION 1 (LEAVE MACHINERY): The option 1 results when Rungas Prime Industries Limited decides to sell it to any potential buyer with appropriate documentations in line with regulatory requirement or leaving it without further action. There are reasons while such facility can be left, reasons like unresolved impasse between project proponent and host community that is perceived to be harmful to both party and requires urgency to evacuate. In either scenario, the advantage is that it cost less to demobilise from site, risk of accidents is reduced. It has some disadvantages that such facilities can be used by hoodlums to perpetrate crimes and such facility can harbour dangerous animals and other living creatures.

OPTION 2 (REMOVAL OF MACHINERY): This option is when the project proponent decides to move all the equipment from the project location. This option has some advantages like, clean up of project site, total removal of all facilities / equipment and the location is total remediated to an acceptable level. The equipment can be reused in other locations. The disadvantages are the project proponent will spend more to remove the equipment. The project proponent can meet stiff resistance from host community.

8.10.5 DECOMMISSIONING AND ABADONMENT PROCESS

Rungas Prime Industries Limited shall conduct the abandonment and decommissioning by following some regulatory processes.

8.10.5.1 PREPARATION OF ENVIRONMENTAL DECOMMISSIONNG REPORT

Rungas Prime Industries Limited shall prepare decommissioning & abandonment environmental report before decommissioning and abandonment. The report shall detail the procedures to be adopted during decommissioning to avoid accidents and any perceivable incident. The report shall be sent to FMENV for approval before decommissioning.

8.10.5.2 SAFETY OF PERSONNEL AND EQUIPMENT

Rungas Prime shall deploy a formidable Occupational health and safety procedures that decommissioning team shall comply with. The personnel shall be well kitted for the task. A holistic and comprehensive risk assessment shall be conducted by the project proponent HSE Team.

8.10.5.3 ENVIRONMENTAL CONSIDERATION

Environmental sustainability is the watchword during decommissioning to avoid environmental pollution. Environmental data gathering (air, soil & water) shall be done and analysed in the laboratory to determine the level of the parameters before decommissioning. All the wastes generated shall be disposed-off and environment left in a habitable condition. The proponent shall send a letter of intent to FMENV informing them of the plan to decommission and abandon the plant.

8.10.5.4 STANDARDS APPLICABLE TO DECOMMISSIONING

The International Organization for Standardization (ISO) has created a list of documents that states the requirements, specifications, guidelines, or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose. For the decommissioning of facilities, every technical process/ analysis shall conform with international standards. These are but not limited to:

TABLE 8.2 :INTERNATIONAL STANDARDS APPLICABLE TO DECOMMISSIONING

ISO /17402:2008	Soil quality -- Requirements and guidance for the selection and application of methods for the assessment of bioavailability of contaminants in soil and soil materials.
ISO/PRF 18504	Soil quality -- Guidance on sustainable remediation (Under development)
ISO /11932:1996	Activity measurements of solid materials considered for recycling, reuse or disposal as non-radioactive waste
ISO /10381-1:2002	Soil quality -- Sampling -- Part 1: Guidance on the design of sampling programmes
ISO/DIS 20761	Water reuse in urban areas -- Guidelines for water reuse safety evaluation: assessment parameters and methods
ISO/TC147/SC6	Water sampling –general methods
ISO 45001	Occupational health and safety
ISO 14000 family	Environmental management
ISO 14004:2016	Environmental management systems -- General guidelines on

CHAPTER NINE

CONCLUSION AND RECOMMENDATION

The Environmental & Social Impact Assessment (ESIA) for the proposed Type 3 Composite LPG Cylinder Manufacturing Plant was carried out in accordance with the Occupational Health, Safety and Environmental local, national, and international standards, using a multi- disciplinary team. In undertaking the ESIA study, a holistic approach was used whereby Project proponent, the Landowners, residents, and the Federal Ministry of Environment were involved. The significance of the impacts was duly assessed through standard field and laboratory methodologies, predictive modelling as well as desk reviews.

This ESIA report includes a draft Environmental & Social Management Plan that will ensure and guarantee minimal adverse effects of the project on the environment. The implementation of the project will significantly open the areas for sustainable development. The project will assist to enhancing building and infrastructural development, boosting employment, and as well as improving the living standard of the people. The proposed project construction will not pose serious threat to the biophysical environment, as most organisms will easily migrate to adjourning pristine environment. This is because the area has been designated as industrial hub.

The ESIA has demonstrated that the overall impacts associated with the project can be managed within reasonable and acceptable limits by applying all identified mitigation measures contained in this report. In consideration of the above therefore, there is no major environmental issue to impede the development of the proposed project, which is designed to improve the LPG supply chain. All the identified potential adverse impacts of the proposed project shall be eliminated or reduced through the implementation of the recommended mitigation measures. The benefits that will be derived from the proposed project are therefore much greater than the short-term environmental effect.

Mitigation measures are developed to be implemented to prevent environmental degradation, it is therefore recommended that the project proponent adopt and ensures full implementation of the mitigation measures stated in the ESIA report to prevent environmental pollution throughout the phases of the project and to decommissioning.

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APPENDIX 1A: FMENV SITE VERIFICATION

FEDERAL MINISTRY OF ENVIRONMENT

Environment House
Independence Way South, Central Business District, Abuja - FCT.
Tel: 09-2911 337 Email:ea@ead.gov.ng, www.ead.gov.ng

ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMEnv/EA/EIA/5538/Vol.1/35
6th August, 2020.

The Managing Director,
Rungas Prime Industries Limited,
14, Adeyemi Lawson Street,
Off Macpherson Avenue,
Ikoyi, Lagos.

RE: APPLICATION FOR ENVIRONMENTAL IMPACT ASSESSMENT REGISTRATION FOR THE PROPOSED (400,000 PER ANNUM) TYPE 3 COMPOSITE LPG CYLINDER MANUFACTURING PLANT AT POLAKU, BAYELSA STATE BY RUNGAS PRIME INDUSTRIES LIMITED

Please refer to your letter dated 19th July, 2020 on the above subject.

2. I am directed to acknowledge the receipt of the evidence of payment with **Remita Retrieval Reference (RRR) No. 1404-0803-5298** dated 19th July, 2020 in the sum of **Fifty Thousand Naira (₦50,000.00)** only, as the EIA registration fee for the proposed project.

3. Please note that the next stage of the EIA Process is Site Verification Exercise which has been scheduled to hold in August, 2020. The exercise will be carried out by the Ministry and other regulators at state level.

4. Consequently, you are to pay the sum of **Four Hundred and Ninety-Three Thousand Naira (₦493,000.00)** only into the Ministry's Treasury Single Account (TSA) being the travel and duty tour allowances of participating officers. Evidence of payment should be forwarded to the Ministry. You are also requested to kindly provide necessary logistics and technical personnel on site to ensure a hitch free exercise.

6. You may contact the undersigned on GSM number **08055270104** for further information on the exercise and to confirm the receipt of this letter.

7. Thank you for your cooperation.

Joshua, Taiwo L.
For: Honourable Minister

APPENDIX 1 B: FMENV LABORATORY ANALYSIS NOTIFICATION LETTER

FEDERAL MINISTRY OF ENVIRONMENT

Environment House
Independence Way South, Central Business District, Abuja - FCT.
Tel: 09-2911 337 Email:ea@ead.gov.ng, www.ead.gov.ng

ENVIRONMENTAL ASSESSMENT DEPARTMENT

Ref: FMEnv/EA/EIA/5538/Vol.1/X

Date: 1st September, 2020

The Managing Director,
Rungas Prime Industries Limited,
14, Adeyemi Lawson Street,
Off Macpherson Avenue,
Ikoyi – Lagos.

ENVIRONMENTAL IMPACT ASSESSENT (EIA) OF THE PROPOSED (400,000 PER ANNUM) TYPE 3 COMPOSITE LPG CYLINDER MANUFACTURING PLANT AT POLAKU, BAYELSA STATE: INVITATION FOR LABORATORY ANALYSIS EXERCISE

Please refer to your letter dated 29th August, 2020 on the above subject matter.

2. I am directed to acknowledge receipt of the letter and forward the nomination of Mrs. Oforji Juliet Nneoma (08060779569) to participate in the exercise.

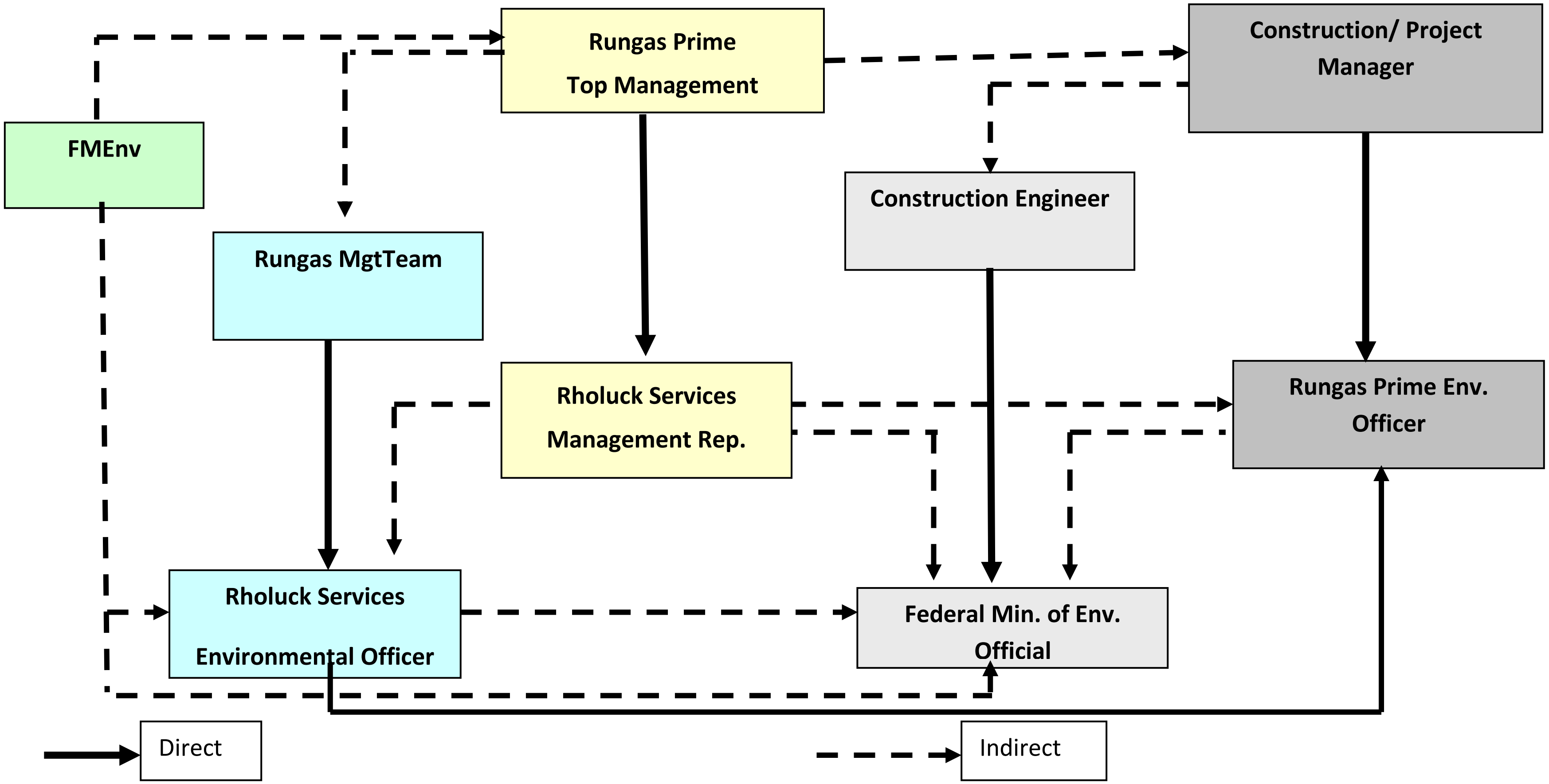
3. I am further directed to request you to make available the sum of One Hundred and Fifty-Seven Thousand Naira (N157,000.00) only, being the Transport and Duty Tour Allowance (DTA) of the participating officer.

4. Please ensure the provision of necessary logistics support for the exercise. You may wish to contact the undersigned on telephone number 08055270104 for any further clarification.

5. Thank you for your cooperation.

Joshua Taiwo .L.
For: Honourable Minister.

APPENDIX 3: PROPOSED PROJECT ORGANISATION CHART



APPENDIX 4 A: PHYSICO/MICROBIOLOGICAL LABORATORY ANALYSIS RESULTS FOR SOIL SAMPLES

S/N	Sample ID	PH APHA 4500 H	Cond APHA 4500C mg/kg	SO4 APHA 4500 mg/kg	NO_3 APHA 4500 mg/kg	NO_2 APHA 4500 mg/kg	TN APHA 4500 mg/kg	NH_3 APHA 4500 mg/kg	TOC APHA 4500 (%)	THB APHA 9215 Cfu/sg	THF APHA 9610 Cfu/g	HUB APHA 907 Cfu/g	HUF APHA 907 Cfu/g
1	SS10-15cm	6.1	14	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1	$2.42x10^6$	$1.78X10^6$	$5.10X10^5$	$1.80X10^5$
2	SS1 15-30cm	5.9	17	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1	$2.11x10^6$	$1.19X10^6$	$8.70X10^5$	$2.20X10^5$
3	SS2 0-15cm	5.6	6.0	4.0	0.05	0.002	1.0	0.49	3.10	$2.16X10^6$	$5.20X10^5$	$9.10X10^5$	$3.10X10^5$
4	SS215-30cm	5.7	8.0	4.0	0.04	0.002	1.1	0.36	2.38	$2.78X10^6$	$1.52X10^6$	$6.30X10^5$	$2.70X10^5$
5	SS30-15cm	5.8	12	<1.0	<0.01	<0.001	<0.1	<0.01	2.42	$2.14X10^6$	$5.20X10^5$	$5.70X10^5$	$1.90X10^5$
6	SS3 15-30cm	5.8	25	<1.0	<0.01	<0.001	<0.1	<0.01	2.22	$2.34X10^6$	$1.52X10^6$	$7.20X10^5$	$2.50X10^5$
7	SS40-15cm	5.5	32	2.0	0.04	0.001	0.6	0.27	1.58	$1.86X10^6$	$7.60X10^5$	$1.10X10^6$	$2.30X10^5$
8	SS415-30cm	5.5	35	2.0	0.06	0.001	0.8	0.36	1.63	$2.42X10^6$	$8.10X10^5$	$9.90X10^5$	$1.70X10^5$
9	SS50-15cm	6.5	10	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1	$2.34X10^6$	$7.20X10^5$	$7.80X10^5$	$2.10X10^5$
10	SS515-30cm	5.7	6.0	<1.0	<0.01	<0.001	<0.1	<0.01	<0.1	$2.53X10^6$	$1.23X10^6$	$9.60X10^5$	$2.60X10^5$
11	SS6 0-15cm	5.6	56	3.0	0.08	0.003	1.2	0.53	1.73	$1.88X10^6$	$8.80X10^5$	$7.50X10^5$	$3.30X10^5$
12	SS6 15-30cm	5.8	84	4.0	0.09	0.004	1.2	0.53	1.56	$2.41X10^6$	$1.36X10^6$	$5.80X10^5$	$2.90X10^5$
13	SS7 0-15cm	6.1	100	2.0	0.05	0.002	0.7	0.36	1.81	$2.15X10^6$	$7.40X10^5$	$5.40X10^5$	$4.90X10^5$
14	SS715-30cm	6.0	105	2.0	0.05	0.003	0.8	0.36	1.53	$2.61X10^6$	$1.16X10^6$	$6.00X10^5$	$3.60X10^5$
15	SS80-15cm	5.8	20	2.0	0.04	0.002	0.6	0.27	1.69	$1.38X10^6$	$1.04X10^6$	$1.15X10^6$	$5.40X10^5$
16	SS815-30cm	5.6	18	2.0	0.06	0.002	0.9	0.40	1.82	$1.78X10^6$	$6.90X10^5$	$8.20X10^5$	$3.70X10^5$
17	SS9 0-15cm	5.0	74	4.0	0.06	0.004	0.6	0.27	<0.1	$1.98X10^6$	$5.30X10^5$	$7.30X10^5$	$2.90X10^5$
18	SS915-30cm	5.0	68	2.0	0.06	0.004	0.8	0.36	<0.1	$2.17X10^6$	$8.70X10^5$	$7.70X10^5$	$3.40X10^5$

APPENDIX 4 B: LABORATORY ANALYSIS RESULTS FOR SOIL PHYSICAL PARAMETERS

S/N	Sample ID	COLOUR	TEXTURE	BULK DENSITY g/cm3	PERMIABILITY ml/s	POROSITY cm/cm	PARTICLE SIZE DISTRIBUTION ASTM 2487-92		
							Sand (%)	Silt (%)	Clay (%)
1	SS1 0-15cm	brown	sandy	22.9	0.01	0.50	95.80	4.20	0.00
2	SS1 15-30cm	brown	sandy	22.1	0.01	0.45	97.10	2.80	0.00
3	SS2 0-15cm	pale brown	sandy/clay	21.6	<0.00001	0.60	15.91	21.00	62.80
4	SS2 15-30cm	pale brown	silt/clay	20.7	<0.00001	0.68	7.40	22.50	71.10
5	SS3 0-15cm	yellow	sandy	22.9	0.01	0.50	97.20	2.80	0.00
6	SS3 15-30cm	yellow	sandy	21.7	0.01	0.50	96.54	3.45	0.00
7	SS4 0-15cm	black	silt/clay	22.1	0.001	0.46	9.30	52.36	38.34
8	SS4 15-30cm	black	silt/clay	21.2	0.001	0.83	3.51	46.67	49.82
9	SS5 0-15cm	yellow	sandy	23.6	0.01	0.50	97.07	2.93	0.00
10	SS5 15-30cm	yellow	sandy	22.9	0.01	0.49	84.33	15.67	0.00
11	SS6 0-15cm	brown	silt/clay	21.7	0.001	0.48	2.39	69.27	28.34
12	SS6 15-30cm	brown	silt/clay	20.1	0.001	0.50	3.02	67.66	29.32
13	SS7 0-15cm	black	silt/clay	21.6	0.001	0.64	2.45	74.97	22.58
14	SS7 15-30cm	brown	silt/clay	20.1	0.001	0.64	4.10	70.64	25.26
15	SS8 0-15cm	brown	silt/clay	21.5	<0.00001	0.64	2.93	20.16	66.91
16	SS8 15-30cm	brown	silt/clay	20.2	<0.00001	0.64	2.64	29.16	68.20
17	SS9 0-15cm	strong brown	silt/clay	21.9	<0.00001	0.68	2.48	22.23	75.29
18	SS9 15-30cm	strong brown	silt/clay	20.1	<0.00001	0.70	2.11	28.60	75.72

APPENDIX 4 C: LABORATORY ANALYSIS RESULTS FOR SOIL HEAVY METALS PARAMETERS

S/N	Sample ID Sampling depth	Ni ASTM D1886 mg/kg	Fe ASTM D1068 mg/kg	Cu ASTM D1688 mg/kg	Cr ASTM D1687 mg/kg	Zn ASTM D1691 mg/kg	Mn ASTM D3558 mg/kg	As ASTM D2972 mg/kg	Cd ASTM D3557 Mmg/ kg	V ASTM D3223 mg/kg	Ba ASTM D3557 mg/kg	Pb ASTM D3557 mg/kg	Hg ASTM D3557 mg/kg
1	SS1 0-15cm	<0.001	3288	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<1.0	<0.001	<0.001
2	SS1 15-30cm	<0.001	3915	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<1.0	<0.001	<0.001
3	SS2 0-15cm	2.964	15669	0.662	0.573	12.15	<0.001	<0.001	<0.001	<0.001	1.0	47.76	<0.001
4	SS2 15-30cm	3.215	16257	0.901	0.601	17.46	<0.001	<0.001	<0.001	<0.001	1.0	53.24	<0.001
5	SS3 0-15cm	<0.001	4029	<0.001	<0.001	<0.001	0.123	<0.001	<0.001	<0.001	<1.0	<0.001	<0.001
6	SS3 15-30cm	<0.001	4355	<0.001	<0.001	<0.001	0.335	<0.001	<0.001	<0.001	<1.0	<0.001	<0.001
7	SS4 0-15cm	2.610	30271	2.318	<0.001	24.36	0.221	<0.001	<0.001	<0.001	1.0	62.34	<0.001
8	SS4 15-30cm	2.857	31241	2.662	<0.001	35.61	0.293	<0.001	<0.001	<0.001	1.0	73.91	<0.001
9	SS5 0-15cm	<0.001	3543	0.073	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<1.0	1.137	<0.001
10	SS5 15-30cm	<0.001	4138	0.201	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<1.0	1.162	<0.001
11	SS6 0-15cm	0.628	29541	3.118	<0.001	48.57	0.113	<0.001	<0.001	<0.001	1.0	18.65	<0.001
12	SS6 15-30cm	1.337	32115	3.572	<0.001	55.34	0.182	<0.001	<0.001	<0.001	2.0	23.74	<0.001
13	SS7 0-15cm	0.514	29234	1.821	0.145	36.78	<0.001	<0.001	<0.001	<0.001	1.0	30.12	<0.001
14	SS7 15-30cm	0.892	31721	1.965	0.128	36.92	<0.001	<0.001	<0.001	<0.001	1.0	33.65	<0.001
15	SS8 0-15cm	2.115	28553	0.635	0.096	26.41	0.201	<0.001	<0.001	<0.001	1.0	54.31	<0.001
16	SS8 15-30cm	3.524	28915	0.922	0.115	31.68	0.382	<0.001	<0.001	<0.001	1.0	58.46	<0.001
17	SS9 0-15cm	2.018	27116	1.383	<0.001	47.79	0.096	<0.001	<0.001	<0.001	<1.0	37.84	<0.001
18	SS9 15-30cm	2.231	33455	1.627	<0.001	58.12	0.124	<0.001	<0.001	<0.001	1.0	45.04	<0.001

APPENDIX 5 A: LABORATORY ANALYSIS RESULTS FOR SURFACE AND GROUND WATER

S/N	Sample ID	PH APHA 4500H	Temp °C	TDS APHA 1030E mg/l	Turb APHA 2130B NTU	DO APHA 422B mg/l	Colour APHA 2120C Pt./Co	Chloride ASTM D512 mg/l	Total Hardness APHA 2340C mg/l	Alkalinity D1067B mg/l	TSS ASTM D1868 mg/l	COD APHA 5220D mg/l	SO_4 APHA 4500 mg/l	NO_3 APHA 4500 mg/l	NO_2 APHA 4500 mg/l	NH_4 APHA 4500 NH_3 mg/l	N APHA 4500N mg/l
1	BH 1	6.8	23.6	76	1.1	2.6	2	24.3	46	0.19	2	1.0	<1	0.03	<0.01	0.05	0.11
2	BH 2	7.2	23.2	47	0.9	3.1	1	14.2	48	0.12	2	1.0	<1	0.07	<0.01	0.09	0.20
3	BH 3	6.8	23.0	60	1.2	2.9	2	21.6	46	0.22	2	1.0	<1	0.05	<0.01	0.06	0.13
SURFACE WATER (SW)																	
1	SW 1	7.2	23.0	22	5.8	3.8	1	8.9	38	0.08	18	0.0	<1	0.03	<0.01	0.04	0.08
2	SW 2	7.2	22.6	22	6.3	3.7	1	8.9	36	0.08	20	0.0	<1	0.03	<0.01	0.03	0.06
3	SW 3	7.2	23.1	22	6.6	3.5	1	8.9	38	0.08	12	0.0	<1	0.02	<0.01	0.04	0.08
4	SW 4	7.2	23.3	23	6.2	3.7	1	8.9	38	0.08	20	0.0	<1	0.03	<0.01	0.04	0.08

SWI: CONTROL SAMPLE-UPSTREAM **SW2: UPSTREAM** **SW3: MID STREAM** **SW4: DOWN STREAMO**

BH: BOREHOLE **BH3: BOREHOLE WATER- CONTROL SAMPLE**

APPENDIX 5 B: SURFACE & GROUND WATER SAMPLES LABORATORY ANALYSIS RESULTS FOR METALS PARAMETERS

S/N	Sample ID	Mn ASTM D858 mg/l	Ni ASTM D1886 mg/l	Fe ASTM D1068 mg/l	Cu ASTM D1688 mg/l	Cr ASTM D1687 mg/l	Zn ASTM D1691 (mg/l)	Pb ASTM D3559 mg/l	Cd ASTM D3557 mg/l	Al ASTM D857 mg/l	As ASTM D2972 mg/l	Ti ASTM E2994 mg/l	B ASTM D3645 mg/l	Mo ASTM D3372 mg/l
1	BH 1	<0.001	<0.001	0.385	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2	BH 2	<0.001	<0.001	0.573	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3	BH 3	<0.001	<0.001	0.109	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SURFACE WATER (SW)														
1	SW 1	<0.001	0.004	1.461	0.282	0.056	<0.001	0.982	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2	SW 2	<0.001	0.002	0.986	0.114	0.011	<0.001	0.715	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3	SW 3	<0.001	<0.001	1.268	0.206	0.025	<0.001	0.396	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	SW 4	<0.001	0.002	1.367	0.137	0.078	<0.001	0.335	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

S/N	Sample ID	Hg ASTM D3223 mg/l	Ba ASTM D4382 mg/l	K ASTM D4192 mg/l	Na ASTM D4191 mg/l	Mg ASTM D511 mg/l	Ca ASTM D511 mg/l	V ASTM D4698 mg/l
1	BH 1	<0.001	<1.0	0.230	5.321	0.162	0.363	<0.001
2	BH 2	<0.001	<1.0	0.340	3.614	0.185	0.358	<0.001
3	BH 3	<0.001	<1.0	0.626	3.227	0.169	0.381	<0.001
4	SW 1	<0.001	<1.0	1.107	0.056	1.170	0.354	<0.001
5	SW 2	<0.001	<1.0	1.211	0.063	1.125	0.347	<0.001
6	SW 3	<0.001	<1.0	1.115	0.063	1.121	0.349	<0.001
7	SW 4	<0.001	<1.0	0.996	0.057	1.219	0.361	<0.001

SWI: CONTROL SAMPLE-UPSTREAM **SW2: UPSTREAM** **SW3: MID STREAM** **SW4: DOWN STREAMO**

BH: BOREHOLE **BH3: BOREHOLE WATER- CONTROL SAMPLE**

APPENDIX 5 C: SURFACE & GROUND WATER SAMPLES LABORATORY ANALYSIS RESULTS FOR ORGANICS/MICROBIOLOGICAL PARAMETERS

S/N	Sample ID	O/G ASTM D3921 mg/l	TPH EPA 8270 mg/l	BTEX EPA 8270 mg/l	PAH EPA 8270 mg/l	BOD APHA 5210	THB APHA 9215 Cfu/ml	HUB APHA 907 Cfu/ml	THF APHA 9610 Cfu/ml	HUF APHA 907 Cfu/ml	T.Coliform APHA 9221B (MPN/100 ml)	F.Coli APHA 9221E (MPN/100 ml)
1	BH 1	<0.001	<0.001	<0.001	<0.001	0.40	$1.41X10^2$	$2.30x10^2$	$1.11X10^2$	NIL	180+	25
2	BH 2	<0.001	<0.001	<0.001	<0.001	0.60	$2.23X10^2$	$1.28x10^2$	$1.25X10^2$	$2.70X10^2$	180+	10
3	BH 3	<0.001	<0.001	<0.001	<0.001	0.40	$2.18X10^2$	$9.20x10^2$	$1.31X10^2$	$1.80X10^2$	180+	25
4	BH 4	<0.001	<0.001	<0.001	<0.001	0.30	$2.12X10^2$	$1.32x10^2$	$1.42X10^2$	NIL	180+	18
SURFACE WATER												
1	SW 1	N/A	N/A	N/A	N/A	3.20	$2.93X10^2$	$1.48x10^2$	$1.62X10^2$	$3.70X10^2$	180+	35
2	SW 2	N/A	N/A	N/A	N/A	0.90	$2.85X10^2$	$1.68x10^2$	$1.55X10^2$	NIL	180+	35
3	SW 3	N/A	N/A	N/A	N/A	1.50	$2.78X10^2$	$1.54x10^2$	$1.63X10^2$	$2.10X10^2$	180+	35
4	SW 4	N/A	N/A	N/A	N/A	1.00	$2.72X10^2$	$2.11x10^2$	$1.83X10^2$	$3.50X10^2$	180+	35

APPENDIX 6 A: LABORATORY ANALYSIS RESULTS FOR SEDIMENT SAMPLES

S/N	Sample ID	PH APHA 4500H	Temp ^{o}C	Chloride ASTM D512 mg/l	SO_4 APHA 4500 mg/kg	NO_3 APHA 4500 mg/kg	NO_2 APHA 4500 mg/kg	NH_4 APHA mg/kg	N mg/kg
1	SED 1	5.5	24.6	3.9	2	0.6	0.07	0.4	1.0
2	SED 2	5.2	24.9	4.2	1	0.4	0.01	0.4	0.9
3	SED 3	5.6	24.8	3.6	3	0.6	0.08	0.5	1.2
4	SED 4	5.5	24.3	6.4	3	0.7	0.08	0.4	0.9

METAL PARAMETERS FOR SEDIMENTS SAMPLES

S/N	Sample ID	Mn ASTM D858 mg/kg	Ni ASTM D1886 mg/kg	Fe ASTM D1068 mg/kg	Cu ASTM D1688 mg/kg	Cr ASTM D1687 mg/kg	Zn ASTM D1691 mg/kg	Pb ASTM D3559 mg/kg	Cd ASTM D3557 mg/kg	Al ASTM D857 mg/kg	As ASTM D2972 mg/kg	Ti ASTM E2994 mg/kg	B ASTM D3645 mg/kg	Mo ASTM D3372 mg/kg
1	SED 1	0.011	0.582	45316	42.87	198.6	77.35	119.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2	SED 2	<0.001	0.634	45432	42.91	265.3	72.41	130.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3	SED 3	<0.001	0.327	43871	31.52	299.4	59.53	382.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	SED 4	0.009	0.384	44964	30.60	284.2	56.86	401.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

SED: Sediments

S/N	Sample ID	Hg ASTM D3223 mg/kg	Ba ASTM D4382 mg/kg	K ASTM D4192 mg/kg	Na ASTM D4191 mg/kg	Mg ASTM D511 mg/kg	Ca ASTM D511 mg/kg	V ASTM D4698 mg/kg
1	SED 1	<0.001	1.0	2275	0.258	3412	159.7	<0.001
2	SED 2	<0.001	2.0	2288	0.332	3350	173.3	<0.001
3	SED 3	<0.001	1.0	2409	0.255	3485	116.2	<0.001
4	SED 4	<0.001	1.0	2382	0.308	3472	115.9	<0.001

APPENDIX 6 B: LABORATORY ANALYSIS RESULTS FOR METAL PARAMETERS IN SEDIMENT SAMPLES

APPENDIX 6C: LABORATORY ANALYSIS RESULTS FOR ORGANICS/MICROBIOLOGICAL PARAMETERS IN SEDIMENT SAMPLES

S/N	Sample ID	O/G ASTM D3921 mg/l	TPH EPA 8270 mg/l	BTEX EPA 8270 mg/l	PAH EPA 8270 mg/l	BOD APHA 5210	THB APHA 9215 Cfu/ml	HUB APHA 907 Cfu/ml	THF APHA 9610 Cfu/ml	HUF APHA 907 Cfu/ml	T.Coliform APHA 9221B (MPN/100 ml)	F.Coli APHA 9221E (MPN/100 ml)
1	SED 1	N/A	N/A	N/A	N/A	N/A	$2.10X10^6$	4.30X105	$2.73X10^5$	$2.20X10^5$	N/A	N/A
2	SED 2	N/A	N/A	N/A	N/A	N/A	$2.32X10^6$	2.10X105	$2.64X10^5$	$1.80X10^5$	N/A	N/A
3	SED 3	N/A	N/A	N/A	N/A	N/A	$2.27X10^6$	6.60X105	$1.86X10^5$	$2.80X10^5$	N/A	N/A
4	SED 4	N/A	N/A	N/A	N/A	N/A	$2.17X10^6$	4.90X105	$2.15X10^5$	$2.10X10^5$	N/A	N/A

SED1: SEDIMENTS (CONTROL SAMPLE-UPSTREAM) **SED2: SEDIMENTS (UPSTREAM)**

SED3: SEDIMENTS (MID-STREAM) **SED4: SEDIMENTS (DOWN STREAM)**

APPENDIX 7 A: LIST OF SOME COMMON IMPORTANT PLANT SPECIES IDENTIFIED IN THE STUDY AREA

Family	Scientific Names		Family	Scientific Names
Palmae	Raphia hookeri		Apocynaceae	Funtumia elastica
	Raphia vinifera		Anonaceae	Cleistopholis Pottens
	Elacis guinensis		Anacadiaceae	Spondianthus preusii
Zingberaceae	Aframomum sceptrum		Moraceae	Musanga sacropoides
	Costus afar		Ochinaceae	Lophyra alata
	Costus Lucanusianus		Rutaceae	Fagara macro phylla
Violaceae	Rinorea subintegrifolia			Zanthoxylum gilletii
	Rinorea brachy petala		Euphorbiaceae	Antidesma laciniatum
Irvingiaceae	Irvingia gabonensis			Macaranga spinosus
	Klainodoxia gabonensis			Macaranga vogelii
Palmae	Calamus deeratus			Aupaca guineensis
Piperaceae	Piper guineensis			Aupaca staudi
	piper umbelatum			*Piptadaniastrum africana*
Bombasaceae	Ceiba pentandra			*Cathomium sp*
Araceae	Cyrtosperma senegalensis			*Albizia adiantifolia*

Combretaceae	Terminalia ivorensis		*Mimosacea*	*Albizia zygia*
Euphorbiaceae	Antidesma venosum			*Pentacleithra macrophylla*
Anonaceae	Xylopia staudtii			*Tetrapleura tetraptera*
Euphorbiaceae	Alchornia cordifolia		*Verbenaceae*	*Vitex grandifolia*
	Symphonia globulifera		*Papilionaceae*	*Pterocarpus santalinoides*
	Spondianthus preusii			*Mucuna flagelipes*
	Spondias mumbim		*Araceae*	*Pistia stratoides(River water)*
Moraceae	Trechilia africana		*Azolaceae*	*Azola Africana (River water)*
	Ficus grandifolia		*Salviniaceae*	*Salvinia nymphellula(River water)*
Maraceae	Ficus ovate		*Pontederaceae*	*Eichhornia crassipes*
Moranthaceae	Thalia welcuitchia		*Poeceae*	*Euchinocloa sp*
Loganiaceae	Anthocleista vogelii		*Nymphacaceae*	*Nympaea Lotus*
	Anthocleista djalonensis		*Rubiaceae*	*Nauclea latifolia*
Rubiaceae	*Mitragyna ciliate*			

APPENDIX 7B-WILDLIFE

METHODOLOGY:

Most of the information on wildlife of the area was derived from interviews with hunters and trapper over the period of our visit and the use of identification keys such as Happold (1987) and more recent books. Interviews were done with demonstration of specimens including inspection of animal footprints, droppings and physical sighting of animals using binoculars and listening to animal calls in the forest within the surrounding forest around the vicinity of the Rungas Prime Industries Ltd proposed site. The list of animals observed is contained on the table below.

TABLE : LIST OF SOME IMPORTANT WILDLIFE COMMONLY FOUND PRESENT WITHIN THE FOREST AND WATER AROUND THE STUDY AREA

MAMMALS

Family	Common name	Scientific name	Ijaw local

Loricidae	Bosman's poto	Perodicticus potto	Imgbisirisi
"	Golden pottos	Agwantibo	Efefei
Suidae	Red river hog	Potamochoerus	Ubi/umbi
Viverridae	Cusimanse	Crossarchus obscures	Kewe
"	African civet cat	Civetticus civetta	Ilorlei
"	Crested genet	Enetta maculate	Punu
Hystricidae	Brush tailed porcupine	Atherus Africana	Lebele
"	Pale bellied pangolin	Manis	
Sciuridae	Zenkers flying squirrel	Idiurus kivuensis	Ubii
Cephalophinae	Red flanked duiker	Cephalophus ruficatus	Aminika
"	Maxwell's duiker	Philantomba Maxwell	Waan
Bovidae	Bush buck	Trigelaphus sciptus	Asala
"	Sitatunga	Trigelaphus spekkei	Utubara
Cephalophinae	Mona monkey	Cercocebus mona	Bugo
"	Olive colobus	Procolobus versus	Osikosiko
Cricetidae	Giant rat	Cricatomys gambianus	Ebue-bue
Sciuridae	Ground squirrel	Protoxerus sp.	Utupiri
"	Giant forest squirrel	Protoxerus stanggeri	
Viverridae	Mash mongoose	Herpestes nato	Kewe
"	Cusimans	Crossarchus platycephalus	Kewe
Thryonomidae	Giant canerat	Tryonomysswinderianus	Pelei
Trichechidae	Manatee	Trichechus senegalensis	Emeyi

APPENDIX 7C- REPTILES

Nile crocodile	*Crocodilus niloticus*	*Segi*
Nile monitor lizard	*Varanus niloticus*	*Abedi*
Dwarf crocodile	*Osteolaemus tetraspis*	*Isibiri*
Royal python	*Python regius*	*Adagba*
African python	*Python sebae*	*Adagba*

APPENDIX 7D- BIRD SPECIES

Common names	Scientific names
Harrier hark	Polybroides redcatus
Dark chanting goshawk	Melierax metabates
Hopper buzzard	Butastus rufipennus
Red neck buzzard	Buteo angularies
Crested hawk	Lophaetus occipitalis
Fish eagle	Haliaetus vocifer
Black kile	Elanus caeraleus
Red tailed bush fisher	Mirafra nigricans
Giant king fisher	Megacerle maxima
Pigmy king fisher	Ceyx pictus
Blue breasted king fisher	Helycon malimbic
Common swift	Apus apus

Little swift	Apus affinis
Cattle swift	Ardeola sp.
Allied hornbill	Tockus fasciatus
Longtailed nightjar	Caprimulgus climatus
Stork	Ciconia sp.
Pigon	Streptopelia sp.
Green fruit pigeon	Treron australis
African grew parrot	Sittacus erithacus
Love bird	Agaporius pullaria

APPENDIX 8 A- BOREHOLE LOG (GEOTECHNICAL SURVEY REPORT)

Logo Benchmark Engineers and Consultants Limited

199433.38m E
556709.59m N

BORING NUMBER BH01

PAGE 1 OF 2

CLIENT Ove Arup & Partners
PROJECT NAME GI for Rungas Prime Industries
PROJECT NUMBER
PROJECT LOCATION Polaku, Bayelsa
DATE STARTED 14/7/20 **COMPLETED** 16/7/20
GROUND ELEVATION **HOLE SIZE** 200mm/150mm
DRILLING CONTRACTOR BECL
GROUND WATER LEVELS:
DRILLING METHOD Percussion Drilling
AT TIME OF DRILLING ---
LOGGED BY Collins **CHECKED BY** Chukwuka
AT END OF DRILLING 1.20 m
NOTES
AFTER DRILLING ---

DEPTH (m)	MATERIAL DESCRIPTION
0.00 – 0.75	Medium dense yellowish subrounded to rounded medium to coarse SAND. Contains subangular fine quartz gravel.
0.75 – 2.50	Firm dark grey firm CLAY of medium to high plasticity
2.50 – 4.95	Dark brown clayey rounded medium SAND
4.95 – 5.50	Dark grey firm CLAY of medium to high plasticity
5.50 – 6.00	Dark brown subrounded to rounded fine SAND
6.00 – 7.20	Dark yellowish brown clayey rounded medium SAND
7.20 – 9.00	Medium dense dark brown subrounded to rounded fine SAND
9.00 –	Medium dense light brown subrounded to rounded fine to coarse SAND. Contains rare to frequent subangular fine quartz gravel.

DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS AND REMARKS
	D		
	D		
2	D		
	D		
	UD		
4	D		
	UD		
	D		
6	SPT	5-9-16 (25)	
	D		
8	SPT	6-10-20 (30)	
	D		
	SPT	8-16-25 (41)	
10	D		
	SPT	10-16-27 (43)	
	D		
12	SPT	10-15-25 (40)	
	D		
14	SPT	10-15-20 (35)	
	D		

(Continued Next Page)

APPENDIX 8 A- BOREHOLE LOG (GEOTECHNICAL SURVEY REPORT)

Logo Benchmark Engineers and Consultants Limited

BORING NUMBER BH01

PAGE 2 OF 2

CLIENT Ove Arup & Partners **PROJECT NAME** GI for Rungas Prime Industries

PROJECT NUMBER **PROJECT LOCATION** Polaku, Bayelsa

DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
	SPT	10-17-21 (38)			Medium dense light brown subrounded to rounded fine to coarse SAND. Contains rare to frequent subangular fine quartz gravel. *(continued)*
16	D				
	SPT	8-12-18 (30)			
	D				
18	SPT	8-12-17 (29)			
	D				
20	SPT	7-11-14 (25)			
	D				
	SPT	7-18-33 (51)			
22	D		22.0m to 30.0m Soil heave due to high water pressure into bore hole, SPT not obtained		
	D				
	D				
24	D				
	D				
26	D				
	D				
	D				
28	D				
	D				
	D				
30				30.00	Bottom of borehole at 30.00 meters.

GENERAL BH / TP / WELL RUNGASPRIME BAYELSA.GPJ GINT STD A4.AS TMLAB.GDT 11/5/20

APPENDIX 8 B- BOREHOLE LOG (GEOTECHNICAL SURVEY REPORT)

Logo Benchmark Engineers and Consultants Limited

199461.43m E
556757.31m N

BORING NUMBER BH02

PAGE 1 OF 2

CLIENT: Ove Arup & Partners	PROJECT NAME: GI for Rungas Prime Industries
PROJECT NUMBER:	PROJECT LOCATION: Polaku, Bayelsa
DATE STARTED: 17/7/20 COMPLETED: 19/7/20	GROUND ELEVATION: HOLE SIZE: 200mm/150mm
DRILLING CONTRACTOR: BECL	GROUND WATER LEVELS:
DRILLING METHOD: Percussion Drilling	AT TIME OF DRILLING: ---
LOGGED BY: Collins CHECKED BY: Chukwuka	AT END OF DRILLING: 1.20 m
NOTES:	AFTER DRILLING: ---

DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS AND REMARKS	MATERIAL DESCRIPTION
0.00–0.75	D			Medium dense light grey subrounded to rounded medium to coarse SAND. Contains subangular fine quartz gravel.
0.75–1.95	D, D			Light grey clayey rounded medium SAND
1.95–4.50	D, UD, D			Firm dark grey firm CLAY of medium to high plasticity
4.50–6.00	D, D			Dark brown clayey rounded medium SAND
6.00–9.00	SPT	4-3-7 (10)		Dark yellowish brown rounded medium SAND
	D			
	SPT	5-10-15 (25)		
	D			
9.00–12.45	SPT	10-16-20 (36)		Medium dense light grey subrounded to rounded fine SAND
	D			
	SPT	12-18-24 (42)		
	D			
	SPT	10-16-20 (36)		
12.45–15.00	D			Medium dense milky white subrounded to rounded fine to coarse SAND. Contains rare to frequent subangular fine quartz gravel.
	SPT	9-16-20 (36)		
	D			

GENERAL BH / TP / WELL RUNGAS PRIME BAYELSA.GPJ GINT STD A4 ASTMLAB.GDT 11/8/20

(Continued Next Page)

APPENDIX 8 B- BOREHOLE LOG (GEOTECHNICAL SURVEY REPORT)

Logo Benchmark Engineers and Consultants Limited

BORING NUMBER BH02

PAGE 2 OF 2

CLIENT Ove Arup & Partners

PROJECT NAME GI for Rungas Prime Industries

PROJECT NUMBER

PROJECT LOCATION Polaku, Bayelsa

DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
	SPT	9-16-26 (42)			Medium dense light grey subrounded to rounded fine to coarse SAND. Contains rare soft clay @18.5m and subangular fine quartz gravel.
16	D				
	SPT	9-16-24 (40)			
	D				
18	SPT	8-10-14 (24)			
	D				
20	SPT	7-12-20 (32)			
	D		20.5m to 30.5m Soil heave due to high water pressure into bore hole, SPT not obtained		
	D				
22	D				
	D				
	D				
24	D				
	D				
	D				
26	D				
	D				
28	D				
	D				
	D				
30					30.00

Bottom of borehole at 30.00 meters.

GENERAL BH / TP / WELL RUNGAS PRIME BAYELSA.GPJ GINT STD A4 ASTMLAB.GDT 11/3/20