**DRAFT REPORT**

**OF**

# ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) FOR THE PROPOSED MINI/ 500MT LPG BLENDING PLANT IBUSA, OSHIMILI NORTH, DELTA STATE, NIGERIA


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**SUBMITTED TO**

**FEDERAL MINISTRY OF ENVIRONMENT (FMENV), ABUJA**

**JULY 2026**

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| | |
|---|---|
| % | Percentage |
| AAS | Atomic Absorption Spectrophotometer |
| AGO | Automotive Gas Oil |
| ALARP | As Low As Reasonably Practicable |
| ANSI | American National Standard Institute |
| APHA | American Public Health Association |
| API | American Petroleum Institute |
| ASME | American Society of Mechanical Engineers |
| ATK | Aviation Turbine Kerosene |
| BAT | Best Available Technology |
| BOD | Biological Oxygen Demand |
| BOD | Basis of Design |
| BRV | Bulk Road Vehicles |
| BS | British Standards |
| BYS | Bayelsa |
| $Ca^{2+}$ | Calcium ion |
| CDC | Community Development Committees |
| CFR | Code of Federal Regulation |
| CG | CORE global services limited |
| CITES | Convention on International Trade in Endangered Species |
| $Cl^-$ | Chloride ion |
| cm | centimeter |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon dioxide |
| COD | Chemical Oxygen Demand |
| $CO_X$ | Oxides of Carbon |
| Cr | Chromium |
| CSR | Concept Selection Report |
| Cu | Copper |
| DBA | Decibel unit (a weighted factor) |
| DO | Dissolved Oxygen |
| DPK | Dual Purpose Kerosene |
| DPR | Department of Petroleum Resources |

| | |
|---|---|
| EC | Electrical Conductivity |
| EGASPIN | Environmental Guidelines and Standard for Petroleum Industry in Nigeria |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| EN | European Standard |
| ESIA | Environmental and Social Impact Assessment |
| Fe | Iron |
| FEPA | Federal Environmental Protection Agency |
| FMA | Federal Ministry of Aviation |
| FMENV | Federal Ministry of Environment |
| ft | feet |
| g | gramme |
| GPS | Global Positioning System |
| Hg | Mercury |
| NMDPRA | Nigerian Midstream and Downstream Petroleum Regulatory Authority |
| HSSSE | Health Safety Security Social and Environment |
| HUBC | Hydrocarbon Utilising Bacteria Count |
| HUF | Hydrocarbon Utilising Fungal |
| HUFC | Hydrocarbon Utilising Fungal Count |
| Irre | Irreversible |
| ISO | International Organization for Standardization |
| ITD | Inter- Tropical Discontinuity |
| IUCN | International Union for Conservation of Nature |
| $K^+$ | Potassium ion |
| KCl | Potassium Chloride |
| $KH_2PO_4$ | Potassium Hydrogen Phosphate |
| m | metre |
| $m^2$ | Square metre |
| mg/l | milligram per liter |
| $Mg^{2+}$ | Magnesium ion |
| ml | milliliter |
| Ni | Nickel |
| NIMET | Nigerian Meteorological Agency |

| | |
|---|---|
| NOx | Oxides of Nitrogen |
| NTU | Nephelometric Turbidity Units |
| OSHA | Occupational Safety and Health Administration |
| Pb | Lead |
| pH | Hydrogen ion concentration |
| PMS | Premium Motor Spirit |
| PMT | Project Management |
| $PO_4^{3-}$ | Phosphate ion |
| ppm | parts per million |
| QHSE | Quality Health Safety and Environment |
| Rev | Reversible |
| ROW | Right of Way |
| μS/cm | Micro Siemens per centimeter |
| $SO_4^{2-}$ | Sulphate ion |
| SON | Standards Organisation of Nigeria |
| SONCAP | Standards Organisation of Nigeria Conformity Assessment Program |
| SOW | Scope of Work |
| SOx | Oxides of Sulphur |
| SPM | Suspended Particulate Matter |
| STN | Station |
| SWL | Safe Working Load |
| TDS | Total Dissolved Solids |
| TFC | Total Fungal Count |
| THBC | Total Hetrotrophic Bacteria Count |
| THC | Total Hydrocarbons |
| THF | Total Hetrotrophic Fungi |
| TOC | Total Organic Carbon |
| TOR | Terms of Reference |
| TSP | Total Suspended Particulates |
| TSS | Total Suspended Solids |
| USEPA | United States Environmental Protection Agency |
| V | Vanadium |
| VOC | Volatile organic carbon |

| | |
|---|---|
| WHO | World Health Organization |
| ZEL | Rainoil Limited/Rainoil Gas Limited |
| Zn | Zinc |

**ACKNOWLEDGEMENT**

Rainoil Limited/Rainoil Gas Limited wishes to express her gratitude to Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA), the project management team of the company and EIA consultants for their contribution towards the preparation of this report.

We are equally grateful to the leaders and members of Ibusa community for the co-operation and understanding displayed throughout the ESMP studies, especially for their high turn out during consultation.

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# EXECUTIVE SUMMARY

## The Proponent

The project proponent, Rainoil Limited through its subsidiary Rainoil Gas Limited, is an indigenous integrated downstream energy company engaged in the sourcing, storage, transportation, distribution, and retail marketing of petroleum products and Liquefied Petroleum Gas (LPG) in Nigeria. Founded in 1994, the company has evolved into a fully integrated enterprise with significant investments in LPG infrastructure, including an 8,000-metric-tonne storage depot in Lagos. Rainoil coordinates its operations from its headquarters in Victoria Island, Lagos, while ensuring compliance with Nigerian environmental legislation and implementing mitigation measures, environmental monitoring, and stakeholder engagement as part of its Environmental and Social Management Plan (ESMP) for the development of an LPG facility. Rainoil also promotes health, safety, and environmental initiatives beyond basic legal compliance.

## Project Overview

The proponent intends to establish the proposed development of a modern Mini 500 MT Liquefied Petroleum Gas (LPG) Blending and Inland Storage Depot with an integrated 25 MT cylinder refilling plant at Ibusa, Oshimili North Local Government Area, Delta State. The facility is designed to receive LPG via road tankers operating under a virtual pipeline system from coastal terminals, gas processing plants and primary storage depots. LPG will be stored in pressurised storage vessels and distributed through controlled bulk loading and direct cylinder filling operations.

The blending process comprises enclosed, pressure-controlled LPG transfer, recirculation and product grade adjustment, where required, to meet established product specifications. All operations will be undertaken within a closed handling system equipped with pressure-rated equipment, instrumentation, emergency shutdown devices, earthing and bonding systems, and comprehensive fire protection measures to ensure operational safety and environmental protection.

The proposed facility will serve as a strategic inland LPG distribution hub, supplying marketers, cylinder filling plants, commercial and industrial users, institutions, households and small businesses. The project supports Nigeria's clean energy transition by expanding access to LPG as a cleaner alternative to traditional fuels, while strengthening Rainoil's downstream petroleum distribution network through enhanced storage, transportation and retail infrastructure.

**Objectives of the Study**

The objectives of the study include:

- to establish the baseline ecological conditions of the proposed 500MT LPG Blending Plant project area at Ibusa, Oshimili North local Government Area of Delta State;
- to use the baseline data to describe and characterize the study area;
- to establish the environmental sensitivities prevalent in the area;
- to identify, quantify, and assess the likely negative and positive environmental impacts of the project as presently designed;
- to identify, evaluate, and predict the impact of the proposed 500MT LPG Blending Plant project on the ecological and socio-economic settings with adequate interfacing and project interaction;
- to identify existing and expected environmental regulations that will affect the operations and advise on standards, concepts and targets;
- to identify any environmental issues and concerns that may, in the future, affect the successful operation of the project;
- to develop control strategies with a view to mitigating and ameliorating significant impacts that the proposed projects would have on the totality of measurable environmental characteristics;
- to develop an effective Environmental and Social Management Plan (ESMP) to last the life-span of the project including compliance, monitoring, auditing and contingency planning.

**Legal and Regulatory Framework for EIA in Nigeria**

The legal and regulatory framework within which the proposed 500MT LPG Blending Plant project by Rainoil Limited/Rainoil Gas Limited at Ibusa, Oshimili North local Government, Delta State shall be executed is entrenched in the broader framework of international, national and local laws and statutes applicable to infrastructures and environment in Nigeria. These include:

- All applicable International Agreements and conventions to which Nigeria is a signatory.
- The regulations, standards, codes and recommended practices of the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA).
- The regulations, standards, codes and recommended practices of the Federal Ministry of Environment (FMEnv).
- The regulations, standards, codes and recommended practices of Delta State Ministry of Environment.
- Rainoil Limited/Rainoil Gas Limited HSSSE Policy

**Need for the Project**

The proposed project is an initiatives to increase the effective and efficient distribution of Liquefied Petroleum Gas (LPG) and reduce the risk associated to the supply of fuels over long distances.

**Project Benefits**

The proposed 500 MT Liquefied Petroleum Gas (LPG) blending and inland storage depot, including a 25 MT cylinder filling plant, aims to provide environmental, social, and economic benefits to Delta State and Nigeria's downstream energy sector. It will enhance LPG supply reliability, reduce reliance on coastal depots, and support a more accessible LPG supply for various sectors. Environmentally, the project promotes the shift to cleaner LPG, reducing pollution and contributing to national sustainability goals. Socio-economically, it will create jobs, boost local businesses, increase government revenue, and enhance energy security. Adhering to modern safety and environmental standards, the project aligns with Nigeria's energy transition strategy, fostering sustainable regional development.

**Project Alternatives**

In compliance with the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004 and aligned with international best practices, alternative development options for supplying Liquefied Petroleum Gas (LPG) to a proposed 500 MT LPG Inland Storage Depot and 25 MT Cylinder Refilling Plant in Ibusa, Delta State were evaluated. Two main alternatives emerged:

**Preferred Option:** The Virtual Pipeline System, which would utilize specialized pressurized road tankers to transport LPG from production facilities and coastal terminals to the depot.

**Alternative Option:** Constructing an 85 km dedicated LPG transmission pipeline from the nearest gas production facility in the Kwale area.

After a thorough assessment of technical, economic, social, and environmental factors, the Virtual Pipeline System was determined to be the most viable option. This system will enable transportation of LPG via specially designed road tankers, thereby eliminating the need for a new transmission pipeline construction between the LPG source and the project location.

**Project Description**

The proposed project involves the establishment of a modern inland Liquefied Petroleum Gas (LPG) storage, blending, and distribution depot in Ibusa, Delta State, with a total storage capacity of 500 metric tonnes and a 25 MT cylinder refilling plant. This strategic infrastructure initiative aims to enhance LPG storage, handling, and distribution within Delta State and neighboring inland areas, strengthening the regional LPG supply chain and supporting Nigeria's clean cooking and energy transition efforts. The facility will utilize a virtual pipeline system for supply, transporting LPG from coastal import terminals and other sources using specialized road tankers. Following a comprehensive security and safety protocol upon arrival, LPG will be transferred through an enclosed, pressure-controlled unloading system into storage, thereby minimizing product loss, preventing atmospheric releases, and maintaining LPG quality. The facility will support both wholesale and retail distribution through two operational streams, ensuring reliable and efficient LPG supply to inland markets. This approach addresses the challenges posed by the absence of conventional gas pipeline infrastructure.

**Project schedule**

The project is scheduled to be completed up to within 15 months from effective start date. The completion date is scheduled for Q2, 2027. The schedule will be revised if the need arises.

**Baseline Conditions**

**Data Acquisition Methods**

Prior to the commencement of the field data gathering process for the ecological baseline data acquisition, a reconnaissance visit was carried out to project area and host communities by the study team lead to firm up sampling strategies, identifies representatives of the host communities that will join the team as local labour and identify options for logistic planning in order to have a hitch-free field campaign. The consultation process that has started at this reconnaissance visit will be maintained throughout the various phases of the study and project execution. The field data gathering activities was carried out between 26th and 27th of June, 2026.

**Summary of Sample Type and Field Method of Collection**

| SAMPLE TYPE | METHOD OF COLLECTION |
|---|---|
| **Soil Samples/Land use** | Dutch Stainless steel hand auger, Shovel, Core Samplers, Interviews, and Direct Observation |
| **Air Quality and Noise** | Electronic air quality monitor, Aeroqul air quality kit, Noise meter |
| **Meteorology** | Literature Survey, Field Studies with Rain Gauge, Thermograph, Wind Vane |
| **Vegetation** | Transects, key Informant Interviews, Direct Observation and sample collection |
| **Wildlife** | Direct Observation, Key Informant Interviews and indirect count method |
| **Geology/Hydrogeology** | Ground water sampling using Teflon water sampler |

All field data gathering methods and laboratory analytical procedures for all the environmental parameters are as stipulated by the Federal Ministry of Environment. Also adequate measures put in place to ensure quality assurance and control of samples collection, handling/preservation, and analytical procedures. All personnel involved in the study were given daily safety briefings and kitted in appropriate working gear to forestall any near misses.

**Existing Baseline Conditions**

**Climate and Meteorology**

The climatic factors considered include temperature, rainfall, relative humidity, wind speed and direction. The study area is located completely in the semi-hot equatorial zone. The climate here reflects conditions of the equatorial rain forest where the temperature and humidity are high all the year round. Also, high and persistent is the amount of rainfall that even in the dry months characterizes the proposed project area. In addition to meteorological data obtained from literature, meteorological parameters such as, wind speed, wind direction, humidity, atmospheric pressure, and temperature were observed during the fieldwork. The measurements reveal low wind speed (1.23-2.45m/s) and predominance SE and SW wind directions with high relative humidity.

**Air Quality and Noise Levels**

The observed air quality data of the study area was within permissible limits recommended by The Department of Petroluem Resources (urrently under the Nigerian Midstream and Downstream Petroleum Regulatory Authority) and Federal Ministry of Environment (FMEnv). $H_2S$ measured during the ESMP study were less than 0.001mg/m$^3$. The mean values for PM2.5, and PM10 ranged from 0.016$\mu g$/m$^3$ to 0.250$\mu g$/m$^3$, and 0.031$\mu g$/m$^3$ to 0.054 $\mu g$/m$^3$ during the ESMP study respectively, which were within permissible limits. The mean data obtained for VOCs within the study area were below equipment detection limit of <0.001mg/m$^3$. The observed VOCs values were relatively lower and less than the FMEnv, NESREA, and EGAPSIN 2018 standards. The noise levels recorded ranged from 43.8 to 65.7 dB(A), with an average value of 52.12±6.49 dB(A) which are within national regulatory limits.

**Surface water Study & Sediment Analysis**

Surface water and sediment investigations were not undertaken for the proposed Mini 500 MT Liquefied Petroleum Gas (LPG) Blending Project because detailed site reconnaissance and baseline environmental surveys confirmed the absence of rivers, streams, creeks, lakes, wetlands or other perennial surface water bodies within a 5 km radius of the project site. Consequently, no hydrologically connected aquatic receptor exists that could reasonably receive project-related runoff, effluent or accidental releases under existing site conditions. In the absence of a natural aquatic environment, surface water and sediment sampling would not provide scientifically meaningful baseline data or support effective environmental impact assessment.

**Hydrobiological Studies**

Hydrobiological investigations were not conducted for the proposed Mini 500 MT Liquefied Petroleum Gas (LPG) Blending Plant Project because baseline environmental reconnaissance confirmed the absence of rivers, streams, creeks, lakes, ponds, wetlands, reservoirs or other permanent surface water bodies within a 5 km radius of the proposed project site. Consequently, no aquatic ecosystem exists within the project area of influence to support representative phytoplankton, zooplankton, benthic macroinvertebrate or fish communities that could provide meaningful baseline ecological data.

From a hydrobiological perspective, the absence of a hydrologically connected aquatic habitat precludes scientifically valid biological sampling and ecological assessment. Accordingly, hydrobiological investigations were considered unnecessary for the baseline study, and the ESMP appropriately focused on groundwater, soil and ambient air quality assessments as the most relevant environmental receptors. Nevertheless, the project incorporates effective stormwater management, spill prevention, drainage maintenance and waste management measures to prevent future contamination of downstream aquatic environments should new drainage pathways or surface water bodies develop over time.

**Soil Studies**

The particle size analysis, expressed as fractions (Sand, Silt and clay) of the dried mineral matter based on PSD analysis of the soil samples showed that sandy loam soil predominates the study area. The values of surface soil (pH) ranged from pH 4.21 to pH 6.27 while that of subsurface soil ranged from pH 4.10 to pH 5.44 across the study areas. The studied soils are, therefore, predominantly acid soils.

Extreme values of electrical conductivity, across soil samples during ranged from 0.016-0.083µS/cm and 0.012-0.079 µS/cm for surface and subsurface soil respectively. The heavy metal profile of soil samples across all sampled soils of the study area indicated the dominance of Fe, Cd, Cr, and Pb. However, the results indicated low values when compared to corresponding naturally occurring soil concentrations reported by Allen, *et al* (1974).

**Geology/Hydrogeology**

The study area (Rainoil Limited/Rainoil Gas Limited Proposed 500MT LPG Blening Plant at Ibusa is part of the geologic sequence of the Quartenary and Tertiary formations of the Niger Delta consisting of three main geological formations – the Benin formation (the topmost unit), the Agbada and the basal unit, the Akata formations. Lithological units of the study area are generally composed of sands, silty sands and clays (Short and Stauble 1967).

The land surface of the study area is characterized by low lying plains typical of the modern Niger Delta. These plains have swamps that are commonly flooded during the peak of the rainy season. The area slopes imperceptibly in the south direction towards the Atlantic Ocean and is drained by a network of Niger River and the adjoining creeks, mangrove swamps, marshes and slots.

The main aquifer system in the Niger Delta region comprises of two stratigraphic units; the Alluvium and the Benin Formation. The Benin formation forms the main aquifer system, having a total thickness of 1892m (6000ft) around Ibusa. Its lithologic composition is mainly (90%) sands and sandstones. The remaining 10% is made up of clay and lignitic beds that are hardly continuous over any significant distance - largely occurring as lenses. Thus, the Benin Formation is one large aquifer system with enormous storage.

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

The groundwater is pH values ranging from 4.1-5.13 at an average temperature of 30.15±0.071°C during the ESMP study. TDS values ranged from 21.46-34.5mg/L. Total suspended Solids concentrations range from 5-6mg/L. The heavy metals concentration revealed that Pb, Cd, Cr, Ni, V, Hg, Ba and Mn were not detected in the groundwater samples (<0.001mg/L)). However, the level of Fe ranged between 0.032 and 0.043 mg/L while that of Zn ranged from 0.017mg/L to 0.026mg/L.

The study area also indicated that the Total Coliform Count (TCC) count in the ground water samples ranged between 47 to 11 MPN/100 mL while the FRainoil Limited/Rainoil Gas Limitedal Coliform Count (FCC) values were not detected (ND) within the proposed project area's groundwater sample

**Vegetation and Wildlife Studies**

The vegetation within the proposed project area is characteristic of a disturbed derived savannah ecosystem comprising farmland, secondary forest, and derived savannah vegetation. The floristic and fauna species was properly documented for the purpose of this study using standard methodology. Anthropogenic activities have strongly influenced the flora and fauna species of the area, resulting in the predominance of secondary successional species with fauna species like rodents that enjoy such habitat. The majority of plant and animal species are of Least Concern (LC), Not Evaluated (NE) or Near Threatened conservation status, while two globally threatened: Vulnerable (VU) plant species were encountered within the project footprint as there was no threatened fauna. There were no Endangered (EN) or Critically Endangered (CR) flora and fauna species in the project area. Consequently, the vegetation and wildlife status is considered to have low ecological sensitivity, and with the implementation of appropriate mitigation measures such as minimizing unnecessary vegetation clearance, preserving economically important trees and animal species where feasible, and restoring disturbed areas after construction, the anticipated impacts of the proposed Mini (500 MT) LPG Blending Plant on vegetation and wildlife species are expected to be minor, localized, and manageable through the project Environmental Management Plan (EMP)

**Land Use**

In the study area, Land in the proposed Rainoil Limited/Rainoil Gas Limited 500MT LPG Blending Plant stakeholder community is an invaluable resource. Traditionally, in Ibusa, Oshimil North LGA, this land have been used over the years for housing, agriculture and in more recent times there have been additional uses for infrastructural development and industrial purposes. However, the main land use structure at the proposed site are Chinese abandoned manufacturing site, block industry between perimeter fence and the express way, adjacent block industry and observed normadic cattle hearding, agriculture.

**Socio-Economic Studies**

The identified stakeholder's community in the proposed Rainoil Limited/Rainoil Gas Limited 500MT LPG Blending Plant is Ibusa. The proposed project site is at Umuobiegwutu Family Land, Idumuobi – Ogalawa Etiti, Ogbeowele Quarters, Oshimili North, Ibusa, Delta State.

The proposed project stakeholder's community is Igbuzor in Oshimili North LGA of Delta State. The community is predominantly inhabited by the Enuani ethnic group of Delta State. Igbuzor (Ibusa) in Delta State is made up of 10 main quarters (Ogbes/kindreds). They are: Umuekea, Umuodafe, Umuidinisagba (Umuisagba), Umueze, Umuehea, Ogbeowele, Anyalaobum (Anyalabum) — including Ezukwu and Achalla-Igbuzo, Umuwagwu, Umuezeagwu and Ogboli. These ten quarters forms the traditional federation commonly referred to as "Igbuzo ebi ili" (Ibusa as one community). They are also grouped traditionally under three major war-chief divisions: Odogwu, Uwolo, and Iyase. Beyond the quarters, Igbuzo (Ibusa) has a very interesting traditional leadership structure and cultural system.

Returned responses from administered questionnaires of the surveyed community revealed on average some 25% to be of single marital status while over one half (58%) were married persons**.** The percentage of respondents divorced, separated from their spouses and those widowed amounted to some 17%, implying that the vulnerable proportion is comparatively low.

The household structure in the proposed Rainoil Limited/Rainoil Gas Limited 500MT LPG Blending Plant stakeholder's community' parallels the patriarchal leadership structure of most Nigerian ethnic groups. The majority (82%) of households in Nigeria are headed by men, with only 18% headed by women. The age distribution of respondent is dominated by youth ranging between 20–49years (52.8%). About 42.4% were found to fall within the age bracket of 50–69 year while above 70 years accounted for only 4.8% and respondents less than 20years account for 2.6%.

Women have an average of 5 children and average household size approximates to 5.3. If other dependants living in the households are added, (a minimum of 2 and maximum of 5 was reported within the community), household size now comes to 10. This trend of large household sizes can be attributed to several reasons in the study community in particular and the South-South (Niger Delta) region as a whole. For instance, people marry at a relatively early age thereby extending their period of child bearing. On the other hand, the men marry more than one wife (i.e polygamy) as well as keep other concubines. On the average, about 55.3% of the sampled respondents are married while about 30.2% are single. Widows' people account for about 4.4%, Divorced 5.3% and Separated 4.8%. This is in conformity with the Delta State marital status where the married and single are higher with 32.3% and 63.6% respectively.

The age and sex demographic classification variables shows that 22.7% of the household population is aged 0-12 years while 25.3% is within the 13-18 years age bracket. Together therefore, children make up 56.6% of total household population. Also 37.4% of the household members are within the productive workforce age cohort of 19-59 years. Household members aged 60 years and above are few, constituting only 6%

The educational status of Ibusa community depicts that some of the population has formal education indicating a literate society. The common classes of educational attainment among the sampled population are the tertiary, post primary and primary education. On the average, 12.4% of the respondents had tertiary education training. Those with post primary (secondary) and primary education accounted for 38.8% and 22.2% respectively. The possession of vocational/technical education among the sampled population is quite high (16.7%) and this is good on occupational skill needed for prospective employment positions that may be offered to members of the communities. Those of NFE constitute 5.4% and 4% others. The educational attainment of the studied community is in conformity with the Delta State educational attainment where the bulk of attainment is in secondary educational level.

The livelihood activities in the proposed RAINOIL LIMITED/RAINOIL GAS LIMITED 500MT LPG Blending Plant project host communities depend much on the natural resource-base and traditional occupations like farming, hunting and lumbering. Farming are the major activity of the people and majorly on crop farming, vegetable, maize, pepper etc.

Responses from administered questionnaires revealed the mean incomes in the communities are as follows; Igbuzor N33,906.26. The modal income bracket at the community is N50, 000 and above. Given the mean income values and assuming naira to United States of America dollar (USD) conversion rate of N1130: 1USD and 30 days in a month, the daily individual incomes will be N1130 or 0.77USD. Using the midpoint of the modal income range (i.e. N52, 500) individual daily incomes in the community will be N1, 733.34 or 1.20USD. Daily incomes in the community are even lower than the World Bank extreme poverty income of 1.9USD.

Household expenditure and consumption pattern gleaned from FGDs ranked in order of concern food as the most important spending priority, with clothing ranked the least in priority in the households.

Lands in the community are primarily owned by extended families, compounds and the community. In the community, families and compounds own lands. Ownership rights over lands are handed down from one generation to another within the extended family, compound and community. Such inherited land is put to any use as desired by the owners. These are the lands on which family, compound and community members build their houses. They are also allocated to members for use as farm lands and for other economic purposes. These lands revert back to the families and compounds at the end of its use. Lands can be leased by non-family and compound members. Such lands similarly revert back to the owners after the period of lease. Lands are managed by males within the extended families and compounds. The study also revealed that 64.4% of lands are owned through family inheritance, 21.4% bought it, 12.4% rented/lease it, while 0% sharecropping and 5.5% others.

These are facilites for recreational activities, meetings and dancing sports for members in the project communities. These include town halls/auditoriums, swimming pools and club/ rest houses.

Traditionally, the governance structure of Obuzor in Igbuzo, hosting the Rainoil Limited 500MT LPG Blending Plant project, is hierarchical. The Obuzor serves as the paramount ruler, symbolizing the foremost leader, while the Senior Diokpa represents the oldest lineage head, maintaining significance in Igbo governance based on age and ancestral authority. Leadership is also evident at the quarter level through Ogbe, each led by a Diokpa-Ogbe and council of elders. The community consists of ten Ogbes linked to three major divisions: Otu Odogwu, Otu Uwolo, and Otu Iyase. Additionally, the Umunna acts at the family level, illustrating a structured approach from the smallest unit to the community government.

**Method of Impact Identification and Evaluation**

The guidelines of ISO 14001 were used for impact prediction and evaluation. This allows for interactive and descriptive analysis of relationships between the proposed project activities and the various environmental components (biophysical, health and social).

The impact evaluation which was based on clearly defined criteria (legal/regulatory requirement, risk, frequency of occurrence, importance and public Interest/concern) was used to determine the significance or otherwise of the impacts.

**Impact Discussion from Proposed Project Activities**

The likely impacts of the proposed project on the biophysical and socio-cultural components in the study area are as follows:

***Land use***: Land aquisation for the proposed are some of the activities that will impact on land use.

***Vegetation:*** Trees, shrubs and herbs will be permanently removed. Stands of more obvious and viable economic species such as *The Hevea brasiliensis*, *Elaeis guineensis*, *Mitragyna stipulosa* among others may be lost. The habitats of these species and homes of animal wildlife will also be lost.

***Biodiversity***: The impact on plant biodiversity will be direct and adverse as species will be lost permanently as a result of site clearing. The impact will also be limited to the acquired area. The impact would be direct and of long-term duration.

***Soil:*** Soil will be exposed to direct sunlight rays due to removal of vegetation. This may elicit erosion, high temperature and changes in soil moistures regimes. This will lead to changes in soil physical and chemical characteristics and subsequent death of soil organisms; promotion of run-off and may impact nearby water body. These impacts will be direct and long term but localized.

***Air Quality***: Project activities like vegetation clearing, etc. will impact the on the air quality due to generation of dust and gaseous emission as a result of movement of heavy machineries. The particulate matters that would be released into the air could reduce visibility.

***Socio-Economics:*** The likely effects of the planned project and related activities on the communities and its total environment are enumerated below:

- **Demographic Changes**

  The proposed project activities, which will involve movement of job seekers, could lead to a temporary net increase in population and moderately affect the demographic pattern. This impact is expected to be direct and indirect, reversible, of short-term duration and rated low.

- ***Increase in social vices***

  The job opportunities created by the project activities and the expected monetary gains could encourage some social vices such as drunkenness, violence and drug abuse. It could also attract commercial sex workers (CSW) and teenage girls to the area. The influx of these categories of people to the area has the potential to increase teenage pregnancies. The impact would be direct, irreversible/reversible, long-term, and rated high.

- ***Pressure on existing infrastructure***

  The relatively large labour force required for project activities could lead to an increase in overall population of the communities. Population increase due to the labour force and migrants could lead to overcrowding and its consequent pressure on existing housing, educational and recreational facilities. The impact would be direct, reversible, short-term, and rated medium.

- ***Community Agitation***

  Land acquisition, destruction of farmlands and other areas of interest and supply of labour could attract third party agitation involving inter- and intra-communal conflicts and human rights issues. The impact would be direct, reversible, short-term, and rated high.

- ***Increase in cost of living/inflation***

  The increase in population which is likely to occur as a result of the movement of people to the project site could overstretch available food supplies, healthcare and other social facilities such as housing, water and power supply. The shortage of these goods and services could result in increase in cost of living and attendant inflation. This impact would be direct, reversible, short-term, and rated medium.

- ***Emergence of new communicable diseases***

The movement of a large number of people (workers and job) into the hitherto isolated, discrete communities could introduce new diseases in the communities if good hygiene is not ensured. This impact would be direct, reversible, of short-term duration and rated medium.

- ***Sexually transmitted infections (STIs), skin and respiratory diseases***

There could be an increase in STIs (including HIV/AIDS), due to anticipated movement of commercial sex workers and increase in sexual risk behaviours. Skin and respiratory diseases could also occur from overcrowding and poor ventilation (poor housing conditions) due to anticipated marginal increase in population. This impact would be direct, irreversible, of long-term duration and rated high.

- ***Soft tissue injury and poisoning***

There could be an increase in soft tissue injuries and poisoning from exposure of field workers and community members to poisonous plants and dangerous animals (snakes, bees, etc.) that have been displaced from their habitats. This impact would be direct, reversible, of short-term duration and rated medium.

- ***Trauma and deaths***

This could result from work-related accidents involving field workers. This impact would be direct, irreversible, of long-term duration and rated high.

- ***Respiratory disorders***

Gaseous discharges and dust particles from vegetation clearing, excavation and heavy machinery/vehicles used during construction, could impair lung functions could lead to or aggravate respiratory disorders such as bronchitis and asthma. This impact would be direct, irreversible, of long-term duration and rated high.

- ***Improvement in Local Economy***

  Positively, the proposed project is expected to benefit the local economy of the host community employment opportunities, the opportunities for contract works and welfare improvements in the host community. All these are capable of having a beneficial multiplier effect on the local economy.

**Mitigation Measures**

Acquisition of land for the project shall involve CDC of the project affected communities and individual families. Adequate compensation shall be paid to the the aquaired land owners.

Clearing of site shall be restricted to right of way in order to reduce ecological damage. Equipment shall be routinely maintained to reduce the introduction of noxious gases into the project area.

Adequate waste disposal strategies shall be put in place during and after construction. Also, workers shall be trained on basic waste management strategies.

Procurement methods shall be skewed in favour of host communities and project affected communities shall be treated fairly and without discrimination.

Construction workers shall be educated on the need to respect the custom and tradition of project affected communities. Temporary camp that would provide basic necessities of workers shall be provided at the already acquired plant site.

The CDC shall be engaged to guide matters concerning the project including employment of locals and engagement of local contractors.

**Environmental Management Plan**

Environmental Management Plan (EMP) is a management tool that presents strategies and procedures for managing potential environmental impacts associated with a proposed project. It provides confidence on the part of project proponent that a reliable scheme has been put in place to deal with any contingency that may arise during the life period of the shore protection project, including construction stages. The details of the EMP including the mitigation measures for identified significant impacts are provided in the report.

The EMP is designed to:

- Ensure that all mitigation measures prescribed in the EIA document for eliminating, minimizing, and enhancing the project adverse and beneficial impacts are fully implemented; and

- Provide part of the basis and standards needed for overall planning, monitoring, auditing and review of environmental and socio-economic performance throughout the project activities.

This has been developed to manage negative impacts/effects, enhance benefits and ensure good standards of practice are used throughout the project. These objectives shall be achieved by:

- Ensuring compliance with all stipulated legislation on protection of the biophysical and socio-economic environment and Rainoil Limited/Rainoil Gas Limited HSSSE policy.

- Integrating environmental and socio-economic issues fully into the project development and operational philosophies.

- Promoting awareness on the management of the biophysical and socio-economic environment among workers.

- Rationalizing and streamlining existing environmental activities to add value to efficiency and effectiveness.

- Ensuring that only environmentally and socially sound procedures are employed during the project implementation; and

- Continuous consultations with the relevant regulatory bodies, community leaders (local heads/chiefs, clan heads, landlords, etc), youth leaders, community-based organizations (CBOs), and other stakeholders throughout the project lifecycle.

In line with the objectives summarized above, the main elements of this EMP stated below are addressed in the main report:

- Overall project organizational chart (including HSSSE) organogram.
- Preliminary EMP guidelines.
- Guidelines for waste management.

- Guideline for Consultation.
- Noise Minimization Guideline.
- Overall safety philosophy/guidelines.
- Emergency/Contingency plan.
- Communication plan.
- Security plan.
- Plan for Training and Awareness.
- Environmental monitoring plan.
- Guidelines for audit and review.
- Application of Equator rinciples;
- Development and Implementation of Resettlement Paln;
- Guidelines on maintenance and facility management; and
- Guidelines for decommissioning and abandonment.

**Conclusion**

The existing biophysical environment does not seem to pose any environmental threat to the project host communities. However, existing health status in terms of health infrastructures is a far cry from minimum expectation. Socio-economic indices prevalent in the project area are fairly good. The communities are peaceful and peace loving blessed with agricultural products. Farming among others are the predominant occupation of the people.

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

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

## CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 General

The project proponent, Rainoil Limited/Rainoil Gas Limited, is an indigenous integrated downstream energy company operating across LPG storage, filling plants, skids, distribution, and retail. Rainoil Limited is recognised as a prominent player in the Nigerian oil and gas industry, with core products including Petrol (PMS) and Diesel, while Rainoil Gas functions within the Rainoil Group with a clear focus on LPG and autogas operations. The company's operational footprint includes an 8,000MT LPG storage depot at Ijegun-Egba, Lagos, supported by a nationwide network of LPG plants, skids, and LPG tank trucks, reflecting its capacity for large-scale downstream logistics and energy distribution. This profile indicates that the proposed project is anchored in an established corporate structure with substantial technical and operational experience in Nigeria's energy supply chain.

The proposed project comprises the development of a modern mini-LPG blending and inland storage depot with a total Liquefied Petroleum Gas (LPG) storage capacity of 500 metric tonnes (MT), integrated with a 25MT cylinder refilling plant to be located at Ibusa, Delta State, Nigeria. The facility is designed to strengthen the downstream LPG distribution network by providing safe, efficient, and reliable storage, handling, and distribution infrastructure that supports increased domestic LPG utilisation and the transition towards cleaner household and industrial energy sources. The project concept aligns with the development of bulk LPG storage and filling infrastructure intended to improve product availability and operational efficiency within the downstream petroleum sector.

LPG will be transported to the facility by specialised road tankers operating under a virtual pipeline distribution model, whereby products are sourced from coastal import terminals, gas processing plants, and primary inland storage depots. Upon arrival, the LPG will be transferred into engineered pressurised storage bullets designed in accordance with recognised engineering and safety standards. From these storage vessels, the product will be distributed through two primary channels: bulk loading into LPG tanker trucks for onward transportation to satellite facilities and commercial customers, and direct filling of domestic and commercial LPG cylinders within the integrated cylinder refilling plant. This operational configuration is intended to ensure supply flexibility, improve distribution efficiency, minimise handling risks, and enhance the availability of LPG across Delta State and neighbouring markets while maintaining high standards of operational safety and environmental protection.

Rainoil Limited/Rainoil Gas Limited (the Proponent) has acquired the land required for the establishment of the proposed MINI/ 500MT LPG Blending Plant. Ibusa, Oshimili North, Delta State, Nigeria.

For the purpose of this Environmental and Social Management Plan (ESMP), the term “blending” refers exclusively to the controlled transfer, recirculation, or adjustment of compliant Liquefied Petroleum Gas (LPG) streams within a fully enclosed and pressurised system to achieve the required product specifications for storage and distribution. The process is limited to the physical handling and mixing of LPG products of compatible composition and does not involve refining, chemical transformation, combustion, fractionation, or any other industrial processing activity. Consequently, the proposed facility is classified as a downstream LPG storage and distribution installation rather than a petroleum processing or manufacturing plant. All blending and product transfer operations will be undertaken within pressure-rated vessels, pipelines, pumps, valves, and associated equipment specifically designed for LPG service. These operations will be supported by appropriate engineering safeguards, including instrumentation and process monitoring systems, electrical earthing and bonding, emergency shutdown (ESD) systems, pressure relief devices, gas detection systems, and fixed fire protection infrastructure to minimise operational risks and ensure compliance with recognised industry standards and environmental, health, and safety requirements. The ESMP therefore provides the framework for identifying, assessing, mitigating, monitoring, and managing the environmental and social risks associated with these activities throughout the project lifecycle.

The proposed facility is intended to function as a strategic inland LPG distribution hub, supporting the efficient movement of LPG from primary coastal terminals and storage facilities to end-users across Delta State and neighbouring regions. The depot will supply LPG to downstream marketers, independent cylinder filling plants, industrial and commercial consumers, public institutions, households, and small and medium-sized enterprises (SMEs), thereby strengthening regional energy security and improving access to cleaner cooking and industrial fuels. Through its storage, handling, and distribution capabilities, the project will reduce supply chain bottlenecks, improve product availability, and enhance operational efficiency within Nigeria's downstream LPG sector. Furthermore, the development is consistent with Rainoil Limited's integrated downstream business model, which encompasses local and international product sourcing, bulk storage, transportation, wholesale distribution, and retail marketing. The project therefore represents a strategic investment that supports the expansion of Rainoil's national LPG value chain while contributing to increased domestic LPG utilisation, economic development, employment generation, and the broader national objective of promoting cleaner and more sustainable energy solutions.

The proposed project comprises the development of a 500MT Liquefied Petroleum Gas (LPG) inland storage and distribution depot integrated with a 25MT cylinder refilling plant and its associated operational infrastructure at Ibusa, Delta State. The facility will include pressurised LPG storage bullets, truck receiving and unloading bays, bulk loading gantries, cylinder filling facilities, pumps, compressors, pipelines, instrumentation and control systems, fire protection installations, administrative buildings, weighbridge, utilities, stormwater drainage, and security systems. These components have been designed to ensure the safe storage, handling, transfer, and distribution of LPG while incorporating internationally recognised engineering controls such as pressure relief systems, emergency shutdown (ESD), gas detection, firewater protection, corrosion control, and preventive maintenance measures to minimise environmental and safety risks.

From an Environmental and Social Impact Assessment (ESIA) perspective, the project has been planned to ensure safe operations, environmental protection, emergency preparedness, efficient logistics, and regulatory compliance throughout the facility's operational life

The site acquired for the proposed 500MT LPG Blending Plant is situated at Umuobiegwutu Family Land, Idumuobi – Ogalawa Etiti, Ogbeowele Quarters, Oshimili North, Ibusa, Delta State, Nigeria. The project is considered a worthwhile business venture which will also facilitate the effective and efficient distribution of Liquefied Petroleum Gas (LPG) and provide employment opportunity to those within and around the vicinity of the subject site while also contributing to the nation’s Gross Domestic Product (GDP).

Rainoil Limited/Rainoil Gas Limited believes and pursues a primary and continuing policy of total commitment to environmental protection, resource conservation and safety of its personnel and others in the conduct of its operations. The company also strives to achieve the most efficient use of its energy resources, high safety standards and environmentally acceptable procedures in compliance with all national and international laws and regulations. However, this is not limited to regulatory compliance but is a total commitment to environmental protection including the rapid response to any contingencies that may arise as a result of its operations.

The proposed project will result in various positive and negative interactions between planned activities and the environment. In line therefore with the statutory requirement for environmental management in Nigeria, Rainoil Limited/Rainoil Gas Limited has conducted the Environmental and Social Management Plan (ESMP) of the proposed project and the findings are documented in this report. The ESMP study has been undertaken in line with statutory requirements for environmental management in Nigeria. These are the National Environmental Policy, the EIA Act No. 86 of 1992 of Federal Ministry of Environment (FMENV) and the Department of Petroleum Resources (DPR) Environmental Guidelines and Standards for The Petroleum Industry in Nigeria (EGASPIN), 2018 under the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) on construction of terminal operations.

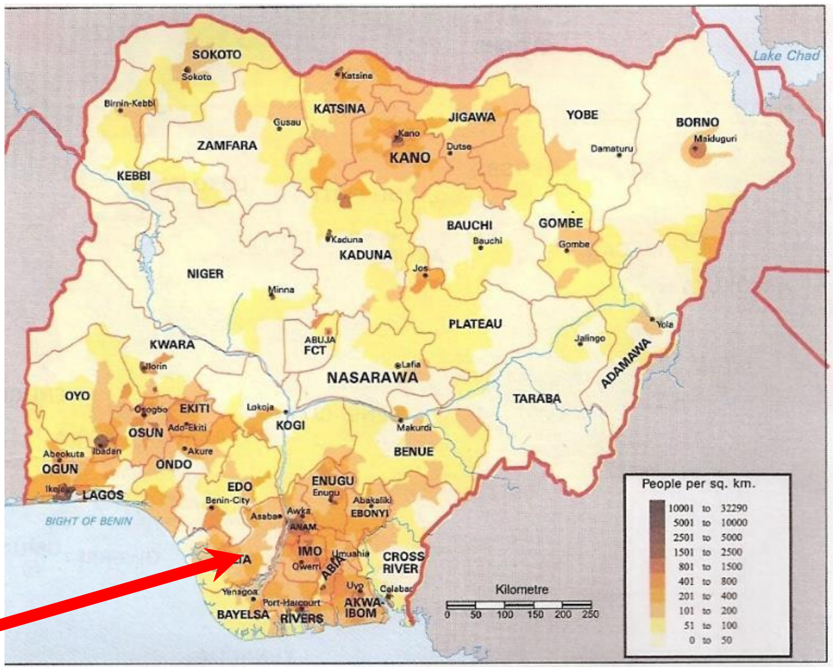
The scope of the study includes gathering extensive baseline environmental data, identifying key stakeholders and stakeholder issues, assessing the potential impacts of the proposed project, proffering practical and cost-effective measures to mitigate identified negative impacts and enhance positive impacts, and development of workable Environmental Management Plan. The Equator Principles (EPs) benchmark for determining, assessing and managing environmental and social risk in projects were applicable.

## 1.2 Project Location

The proposed MINI/500MT LPG Blending Plant is situated in a total land area of 11277.650 square metres of Land at Idumuob-Ogalawa Etiti, Ogbeowele Quarters, Ibusa, Oshimili North Local Government Area (LGA) of Delta State, Nigeria (Plate 1.1, Figure 1.1). The proposed Project Area at Ibusa (Igbuzo), a prominent urban community in Oshimili North Local Government Area (LGA) of Delta State, Nigeria. Oshimili North has its administrative headquarters at Akwukwu-Igbo and is bordered by other local government areas within Delta State. The area is strategically located along the Ogwashi-Igbuzor Expressway, providing excellent road connectivity to Asaba, Onitsha, Benin City, and other major commercial centres in southern Nigeria. Ibusa lies within the tropical savanna (Aw) climatic zone at approximately 6°10′35″N latitude and 6°37′45″E longitude, characterised by distinct wet and dry seasons that influence environmental conditions and project operations.

Ibusa occupies a land area of approximately 175 km² and, according to the 2006 National Population and Housing Census conducted by the National Population Commission (NPC), has a population of approximately 99,566 persons. The community has experienced continued population growth due to urban expansion associated with the nearby state capital, Asaba. The predominant occupations include agriculture, trading, transportation, public service, and small- and medium-scale enterprises, making the community an important commercial and residential centre within Oshimili North LGA.

The project site benefits from existing transportation infrastructure, accessibility to regional LPG markets, and proximity to residential, commercial, and institutional developments. These characteristics make Ibusa a suitable location for an inland LPG storage and cylinder refilling facility, while also necessitating careful environmental and social management to safeguard nearby communities, public infrastructure, and ecological resources. Consequently, the ESMP identifies appropriate mitigation measures to address potential environmental, occupational health and safety, traffic, noise, air quality, and community safety impacts throughout the construction, operation, and decommissioning phases of the project.




Delta State

**Figure 1.1: Map of Nigeria Showing the Location of Delta State**


**Figure 1.2. Location of proposed project Site. Source: Survey plan**

## 1.3 The Proponent

The project proponent is Rainoil Limited, acting through its LPG business subsidiary, Rainoil Gas Limited, an indigenous integrated downstream energy company engaged in the sourcing, storage, transportation, distribution, and retail marketing of petroleum products and Liquefied Petroleum Gas (LPG) across Nigeria. The company forms part of the Rainoil Group and has established a significant presence within Nigeria's downstream oil and gas sector through investments in fuel retail outlets, bulk storage facilities, LPG infrastructure, logistics, and supply chain operations. Rainoil Gas is responsible for the Group's LPG and autogas business, supporting the expansion of clean cooking and alternative transportation fuels through an extensive national distribution network.

Rainoil Limited was incorporated in November 1994 and commenced commercial operations as a petroleum products marketing company in May 1997. Since its incorporation, the company has expanded from conventional petroleum marketing into a fully integrated downstream energy enterprise with investments in petroleum product depots, LPG storage and filling plants, transportation assets, and retail service stations. A major component of its LPG infrastructure is an 8,000-metric-tonne LPG storage depot located at Pioneer Drive, off Marwa Road, Ijegun-Egba, Lagos, which serves as one of the company's strategic bulk storage and distribution centres for LPG nationwide.

The corporate headquarters of Rainoil Limited is located at 35 Kofo Abayomi Street, Victoria Island, Lagos, Nigeria, from where the company coordinates its corporate governance, business development, engineering, finance, health, safety, security, environmental (HSSE), and operational management activities. In addition to its corporate headquarters, Rainoil operates strategic operational facilities across Nigeria, including petroleum depots, LPG storage terminals, filling plants, and an extensive network of retail outlets, enabling efficient nationwide distribution of petroleum products and LPG.

For the purpose of this Environmental and Social Management Plan (ESMP), Rainoil Limited/Rainoil Gas Limited is the project proponent responsible for the planning, financing, construction, operation, maintenance, environmental compliance, occupational health and safety management, and eventual decommissioning of the proposed LPG facility. Accordingly, the company is responsible for ensuring that all project activities comply with applicable Nigerian environmental legislation, health and safety regulations, industry standards, and international good practice throughout the project lifecycle. The proponent is also responsible for implementing all mitigation measures, environmental monitoring programmes, stakeholder engagement activities, emergency preparedness procedures, and social management commitments contained within this ESMP.

However, Rainoil Limited/Rainoil Gas Limited not only complies with relevant legislation, but also encourages other initiatives for protecting the health, safety and environment of those affected by its activities.

## 1.4 EIA/ESMP Objectives

The objectives of the study include:

- To establish the baseline ecological conditions of the proposed MINI 500MT LPG Blending Plant at Ibusa, Oshimili North local Governement Area of Delta State;
- To use the baseline data to describe and characterize the study area;
- To establish the environmental sensitivities prevalent in the area;
- To identify, quantify, and assess the likely negative and positive environmental impacts of the project as presently designed;
- To identify, evaluate, and predict the impact of the proposed MINI 500MT LPG Blending Plant on the ecological and socio-economic settings with adequate interfacing and project interaction;
- To identify existing and expected environmental regulations that will affect the operations and advise on standards, concepts and targets;
- To identify any environmental issues and concerns that may, in the future, affect the successful operation of the project;
- To develop control strategies with a view to mitigating and ameliorating significant impacts that the proposed projects would have on the totality of measurable environmental characteristics;
- To develop an effective Environmental Management Plan (EMP) to last the life-span of the project including compliance, monitoring, auditing and contingency planning.

## 1.5 EIA Work scope

EIAs include environmental, social, and consultation elements which are integrated into the planning and decision-making process to avoid, reduce, or mitigate adverse impacts and to maximise the benefits of a proposed project.

The emphasis of the EIA is to produce robust environmental and social management plans (EMPs) which are able to effectively implement the recommended mitigation measures identified in the EIA, during the life of the Project and at the time of project decommissioning.

The overall EIA process is shown schematically in **Figure 1.3** and the following key steps are described in the subsequent sections.

- Review of relevant national and international environmental regulations guiding onshore gas pipeline installation and operations;
- Comprehensive literature review on the biogeophysical characteristics of the project area;
- Screening and scoping
- Baseline data collection
- Laboratory analysis of samples collected from field survey/sampling;
- Stakeholder consultation
- Impact assessment
- Management plans
- Reporting and disclosure

## 1.6 Legal and Administrative Framework for the EIA

Projects such as MINI 500MT LPG Blending Plant establishment are governed by regulatory legislations, guidelines and standards. Thus, the EIA of the proposed Ibusa MINI 500MT LPG Blending Plant was carried out in accordance with regulations, guidelines and standards of the Department of Petroleum Resources, Federal Ministry of Environment, State legislations on the environment, and all other applicable National legislations, and

International Agreement and Convention to which Nigeria is a signatory. The EIA is also in conformity with Rainoil Limited/Rainoil Gas Limited HSE policy.

### 1.6.1 Legislations/body guiding Environmental management in Nigeria

**The Mineral Oil (Safety) Act CAP 350 LFN 1990**

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.

#### 1.6.1.1 Federal Environmental Protection Agency (Now FMEnv) Act No. 58, 1988

This Act, which was issued in 1988 and amended by Act No. 59 of 1992, provides the setting up of the Federal Environmental Protection Agency, as the apex organization for the overall protection of the Environment and Conservation of Natural Resources. The act also makes environmental impact assessment (EIA) mandatory for all new major projects. In compliance with its mandate, FEPA issued the procedure, guidelines and standards for the execution of EIA with emphasis on the significance associated with current and potential impacts of such projects. The procedure also indicates the steps to be followed (in the EIA process) from project conception to commissioning in order to ensure that the project is executed with adequate consideration for the environment.

#### 1.6.1.2 Petroleum (Drilling and Production) Regulations (1969)

The Petroleum (Drilling and Production) Regulations (1969), empowers the holder of an OPL to do practically anything in the area covered by the license {Section 15 (1)}, but Section 15(2) holds such a holder responsible for all the actions of his agents and contractors.

#### 1.6.1.3 EIA Sectoral Guidelines for Oil and Gas Industry Projects, 1995

In compliance with its mandate, FEPA issued the EIA Sectoral Guidelines for Oil and Gas Industry Projects, 1995. Contained in the Procedural Guidelines (pg. 8) are Category I projects (mandatory study activities) and listed under item 15, sub-item (a) on page 10) (Petroleum) is Oil and Gas Fields Development, making an EIA mandatory for the proposed project. The Procedural Guidelines also indicate the steps to be followed (in the EIA process) from project conception to commissioning in order to ensure that the project is executed with adequate consideration for the environment. Annex C contains the EIA writing format as required by FMEnv. The guidelines are intended to assist in the proper and detailed execution of EIA studies of projects in consonance with the EIA Act.

**1.6.1.4 National Environmental Protection Management of Solid and Hazardous Wastes Regulation (1991) (FMEnv)**

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

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

**1.6.1.5 Environmental Impact Assessment Act CAP E12 LFN 2004**

The Act sets out general principles, procedures and methods to enable the prior consideration of Environmental Impact Assessment on certain public or private projects. The objectives of the Act is to promote the implementation of appropriate policies consistent with all the laws and decision making processes through which the goal and objectives maybe realized. The Act also encourages the development of procedures for information exchange, notification and consultation between the organs and persons when proposed projects or activities are likely to have significant environmental effects on boundary or trans-state or on the environment of bordering towns and villages.

**1.6.1.6 FEPA (Now FMEnv) National Policy on the Environment (1989)**

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

**1.6.1.7 FEPA (Now FMEnv) Nigeria's National Agenda 21 (1999)**

Nigeria's National Agenda 21 was developed to:

- Integrate environment into development planning at all levels of government and the private sector,
- Intensify the transition to sustainable development,
- Address sectoral priorities, plans, policies and strategies for the major sectors of the economy and,
- Simultaneously foster regional and global partnerships.

**1.6.1.8 National Inland Waterways Authority Act No 13 of 1997**

Established by the National Inland Waterways Authority Act No. 13 of 1977, it is the function of the Authority to

- Grant permit and licences for sand dredging, pipeline construction, dredging of slots and crossing of waterways, and;
- Subject to the provisions of the Environmental Impact Assessment Act No. 86 of 1992, carry out environmental impact assessment of navigation and other dredging activities within the inland water and its right-of-way.

Contained in Part VI of the Act are offences and penalties. It states that subject to the provisions of the Lands Act, 1993 and the Nigerian port Act 1993, any person who wilfully or negligently and without the consent of the Authority obstructs the waterways with rafts, nets, logs, cask of oil, dredgers, barges, pipelines, pylons, or bridges shall be liable upon conviction to a fine.

**1.6.1.9 Endangered Species Act CAP E9 LFN 2004**

This Act prohibits hunting, capture and trade of some *endangered species* like crocodile, alligator, turtles, Parrot, etc. The Endangered (Control of International Trade and Traffic) Decree (No. 11 of 1985) has been enacted by the Federal Republic of Nigeria specifically to implement CITES. It is broader than CITES in that it also covers domestic taking of listed species. Two schedules are included: Schedule I (Endangered Species – Animals in relation to which International Trade is absolutely Prohibited), and Schedule 2 (Animals in Relation to which International Trade may only be conducted under License). The decree prohibits taking of Schedule 1 species and requires that taking of Schedule 2 species be in accordance with a license issued under the decree.

#### 1.6.1.10 Petroleum Act 1969

Section 9-(1) (b) (iii) of the Petroleum Act 1969 (Decree 51) states that the Minister of Petroleum Resources may make regulations on "the prevention of pollution of water courses and the atmosphere".

#### 1.6.1.11 Petroleum Act CAP 350 LFN 1990

An Act to provide for the exploration of petroleum from the territorial waters and the continental shelf of Nigeria and to vest the ownership of, and all on-shore and off-shore revenue from petroleum resources derivable therefrom in the Federal Government and for all other matters incidental thereto.

#### 1.6.1.12 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 -

(a) is committed within the territorial waters in Nigeria, whether by a citizen of Nigeria or a foreigner; and

(b) 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

#### 1.6.1.13 Nigerian Oil and Gas Industry Content Development Act 2010

The Act provides for the development of Nigerian Content in the Nigerian Oil and Gas Industry, Nigerian Content Plan, Supervision, Coordination, Monitoring and Implementation of Nigerian content and for related matters. All regulatory authorities, operators, contractors, subcontractors, alliance partners and other entities involved in any project, operation, activity or transaction in the Nigerian oil and gas industry shall consider Nigerian content as an important element of their overall project development and management philosophy for project execution.

### 1.6.1.14 Nigerian National Petroleum Corporation (NNPC) Act, Cap. N123, Laws of the Federation of Nigeria (LFN) 2004

The Nigerian National Petroleum Corporation (NNPC) Act, Cap. N123 LFN 2004 established the Nigerian National Petroleum Corporation as the national oil company responsible for managing the Federal Government's commercial interests in the petroleum industry. The Act empowered the Corporation to undertake petroleum exploration, production, processing, transportation, storage, marketing, and related commercial activities through direct operations or joint ventures. It also provided the legal basis for developing petroleum infrastructure, including depots, pipelines, terminals, and storage facilities that supported the growth of Nigeria's oil and gas industry.

From an Environmental and Social Management Plan (ESMP) perspective, the Act historically provided the institutional framework within which petroleum projects operated before the enactment of the Petroleum Industry Act (PIA), 2021. Although the NNPC Act contained limited standalone provisions on environmental management, project proponents were required to comply with applicable environmental legislation, safety regulations, and government directives governing petroleum operations. Consequently, environmental protection, occupational health and safety, pollution prevention, emergency preparedness, and infrastructure integrity were implemented through complementary legislation administered by environmental and petroleum regulatory agencies. While the NNPC Act has largely been superseded by the Petroleum Industry Act, 2021, it remains important in understanding the historical evolution of Nigeria's petroleum governance and regulatory framework.

### 1.6.1.15 Petroleum Industry Act (PIA), 2021

The Petroleum Industry Act (PIA), 2021 represents the principal legislation governing Nigeria's petroleum industry and provides a comprehensive legal, governance, regulatory, administrative, and fiscal framework for upstream, midstream, and downstream petroleum operations. The Act introduced major institutional reforms by restructuring the former Nigerian National Petroleum Corporation into NNPC Limited, creating independent regulatory institutions, and establishing clearer responsibilities for licensing, technical regulation, environmental compliance, safety management, commercial operations, and host community development.

For the proposed 500 MT LPG inland storage depot and 25 MT cylinder filling plant, the PIA provides the primary legal framework governing the design, construction, commissioning, operation, maintenance, and decommissioning of downstream petroleum facilities. The Act requires operators to obtain the appropriate licences and permits, maintain safe operational standards, implement risk management systems, ensure asset integrity, prevent pollution, protect public health and safety, and comply with applicable environmental laws and technical regulations. It also strengthens regulatory oversight through performance monitoring, inspection, enforcement, and sanctions for non-compliance.

A significant feature of the PIA is its emphasis on sustainable development and host community participation. The Act promotes responsible environmental stewardship, encourages the prevention and mitigation of environmental impacts arising from petroleum operations, and establishes mechanisms to foster positive relationships between petroleum operators and host communities. These provisions support stakeholder engagement, conflict prevention, social investment, and improved community participation throughout the project lifecycle. Accordingly, implementation of this ESMP contributes to achieving the objectives of the PIA by providing practical measures for environmental protection, occupational health and safety, emergency preparedness, waste management, pollution control, monitoring, and continuous improvement in environmental and social performance.

#### 1.6.1.16 Employee's Compensation Act No. 13, 2010

The objectives of the Act are to— (a) provide for an open and fair system of guaranteed and adequate compensation for all employees or their dependants for any death, injury, disease or disability arising out of or in the course of employment; (b) provide rehabilitation to employees with work-related disabilities as provided in this Act; (c) establish and maintain a solvent compensation fund managed in the interest of employees and employers; (d) provide for fair and adequate assessments for employers; (e) provide an appeal procedure that is simple, fair and accessible, with minimal delays; and (f)combine efforts and resources of relevant stakeholders for the prevention of workplace disabilities, including the enforcement of occupational safety and health standards.

### 1.6.1.17 FEPA (Now FMEnv) National Guidelines for Spilled Oil Fingerprinting (Act 14 of 1999)

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

### 1.6.1.18 The Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)

According to the Petroleum Industry Act 2021, which establishes a legal, administrative, regulatory, and financial framework for the Nigerian petroleum industry and promotes the development of host communities, the Nigerian Midstream and Downstream Petroleum Regulatory Authority (also known as "The Authority") was established in August 2021.

The Petroleum Products Pricing Regulatory Agency (PPPRA), the Petroleum Equalization Fund Management Board (PEFMB), and the Midstream and Downstream Divisions of the Department of Petroleum Resources (DPR) have been combined to form the NMDPRA. A new era in the development of a progressive regulatory system that promotes investment and the full optimization of Nigeria's midstream and downstream petroleum industry has begun with this birth.

The Department of Petroleum Resources was in charged with the specific responsibilities of regulating activities in the Oil and Gas industry in order to ensure strict compliance with relevant regulations.

The DPR performs its regulatory functions under the mandate of the Petroleum Minister as provided for in the provisions of the Petroleum Act 1969, which empowers the Minister to make regulations for all petroleum operations including environmental matters. Under the Petroleum (Drilling and Production-Amendment) Regulations 1988, DPR is responsible for monitoring compliance with the Minister’s regulations and approved control methods and practices. These requirements are detailed in DPR’s “Environmental Guidelines and Standards for the Petroleum Industry in Nigeria” (EGASPIN Revised Edition 2018). The guidelines also provide for the establishment and management of Terminal operations (PART IV, section 1 to 6).

#### 1.6.1.19 Abandonment Guideline

As far as abandonment of facilities is concerned, the applicable guidelines shall be as required by FMENV for oil and gas/infrastructural facilities and the EGASPIN of 2018 (NMDPRA). The NMDPRA EGASPIN (2018) stipulates that an operator, whose activity has been known to cause significant adverse environmental effect, should restore it as much as possible to its original state. This also deals mainly with oil spill sites. It is envisaged that more comprehensive guidelines and standards for abandonment of facilities will soon be enacted.

#### 1.6.1.20 Oil Pipelines Act of 1956

Concerns construction, maintenance and operation of oil and gas pipelines. Section 11(2) of the Act provides for the definition of an oil pipeline as follows: "For the purposes of this Act an oil pipeline means a pipeline for the conveyance of mineral oils, natural gas and any of their derivatives or components, and also any substance (including steam and water) used or intended to be used in the production of refining or conveying of minerals oils, natural gas and any of their derivatives or components".

The Federal Republic of Nigeria Official Gazette of 2nd October, 1995 Vol. 82, No. 26 on Oil Pipelines Acts provides in detail all the regulations on pipelines, proposed routes, construction activities and the associated protection measures. Consideration for public safety shall be in accordance with the provision of API/RP 1102 or any other recognized equivalent standards

#### 1.6.1.21 Criminal Code

Section 247 of the Nigerian Criminal Code makes it an offence, punishable with up to 6 months imprisonment for "Any person who: a) violates the atmosphere in any place, so as to make it noxious to the health of persons in general dwelling, or conducting business in the neighbourhood, or passing along a public way or; b) does any act which is, and which he knows or has reason to believe to be, likely to spread the infection of any disease dangerous to life, whether human or animal."

### 1.6.1.22 Land Use Act 1978

The Land-use Act of 1978 states that "...it is also in the public interest that the rights of all Nigerians to use and enjoy land in Nigeria and the natural fruits thereof in sufficient quality to enable them to provide for the sustenance of themselves and their families should be assured, protected and preserved". This implies that acts which could result in the pollution of the land, air and waters of Nigeria negates this decree, and are therefore, unacceptable.

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

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

### 1.6.1.24 Endangered Species (Control of International Trade and Traffic) Act 11 of 1985

This Act prohibits hunting, capture and trade of some *endangered species* like crocodile, alligator, turtles, Parrot, etc.

The Endangered (Control of International Trade and Traffic) Decree (No. 11 of 1985) has been enacted by the Federal Republic of Nigeria specifically to implement CITES. It is broader than CITES in that it also covers domestic taking of listed species. Two schedules are included: Schedule I (Endangered Species – Animals in relation to which International Trade is absolutely Prohibited), and Schedule 2 (Animals in Relation to which International Trade may only be conducted under License). The decree prohibits taking of Schedule 1 species and requires that taking of Schedule 2 species be in accordance with a license issued under the decree.

### 1.6.1.25 Delta State Environmental Protection Agency Edict No 5 of 1997

The DSEPA is an agency under the Delta State Ministry of Environment. Although the EIA decree No 86 of 1992 is the substantive law that regulates the sitting of industrial projects that impinge on environmental elements in Nigeria, with part of the project in Delta State, this edict has a role to play in the overall EIA process as a matter of law. The Edict setting up the

Delta State Environmental Protection Agency (DELSEPA) captioned as Edict No 5 of 1997 outlines the primary responsibilities of the agency, which is to protect and develop the general environment of Delta State.

#### 1.6.1.26 Delta State Ecology Law, 2006

The law empowers the Delta State Ministry of Environment with the responsibility of protecting the environment in order to achieve sustainable environmental development in the State. It empowers the Ministry with the statutory responsibility of handling environmental pollution cases. It liaises with oil companies on pollution matters. It enables, the Ministry to participate in the management of oil spills in the State. It empowers the Ministry to be an integral part of the Joint Investigation team (JIV) that investigates the causes of oil spills; carrying out assessment of damage to the environment, property, health and assessment of the ecological damage to the marine and terrestrial habitat as well as vegetation and ecosystem. The law also empowers the Ministry to handle flood and erosion cases.

#### 1.6.1.27 Delta State Revenue Edict, 1997

This edict appropriates sources of revenue in Delta State to include Internally Generated Revenue, Statutory Allocation from the Federal Government, Value Added Tax and Other Capital Receipts. It also appropriates expenditure sources to include Recurrent Expenditure and Capital Expenditure

#### 1.6.1.28 Delta State Waste Management Law, 2004

This law establishes the Delta State Waste Management Board charged with evacuation and management of wastes. The issue of waste evacuation is the statutory responsibility of the Local Government Councils. However, due to financial constraints they have not been able to exercise this function effectively. As a result, the State Government has intervened in waste evacuation and management in the State through the Waste Management Board

#### 1.6.1.29 Delta State Internal Revenue Consolidation Law, 2009

The law is aimed at improving tax administration, tax revenues and enhancing the ability of government to fruitfully pursue the diversification of the State's economy and to create more wealth and generate employment for the teeming youth population of the State

#### 1.6.1.30 Nigerian Ports Authority Act No 38 of 1999

Nigerian ports Authority (NPA) was established in 1954 by ports Act (Cap 155 of the law of the Federation of Nigeria –amended 1999) as an operating port with the responsibility of providing all port services.

- Ownership and administration of land and water within port limits.
- Planning and development of port operational infrastructure.
- Leasing and concession of port infrastructure and setting bench mark for tariff structure Responsible for nautical/Harbour operations and hydrographic survey.
- Marine incidents and pollution
- Maintenance of safety and security at the common user areas.
- Enacting port regulations and bye-laws as well as monitor and enforce them
- Day to day monitoring of operations and enforcement of relevant sections of respective agreements.

### 1.6.2 International Guidelines and Convention

#### 1.6.2.1 International Laws and Regulations

Nigeria is signatory to several laws, treaties and regulations that govern the environment.

Among these are:

(a) United Nations Framework Convention on Climate Change (1992)

(b) International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines

(c) Convention on the Migratory Species of Wild Animals (Bonn Convention)

(d) Convention of Biological Diversity

(e) Convention Concerning the Protection of the World Cultural and National Heritage Sites (World Heritage Convention)

(f) Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal and.

(g) World Bank Guidelines on Environmental Assessment {EA} (1991)

**1.6.2.2 United Nations Framework Convention on Climate Change (1992)**

In order to achieve sustainable social and economic development, energy consumption for developing countries 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.

**1.6.2.3 International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines**

The IUCN in conjunction with the Oil Industry International Exploration and production Forum presented a set of guidelines for oil and gas exploration and production in mangrove areas. These guidelines are aimed at conservation of mangroves and enhancing the protection of marine ecosystems during E & P activities. The document also discusses the policy and principles for environmental management in mangrove areas as well as EIA procedures, Environmental Audit and Monitoring.

**1.6.2.4 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).**

The Bonn Convention concerns the promotion of measures for the conservation and management of migratory species.

**1.6.2.5 Convention on Biological Diversity**

The objectives of the Convention include the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

**1.6.2.6 Convention Concerning the Protection of the World Cultural and Natural Heritage Sites (or World Heritage Convention)**

The convention sets aside areas of cultural and natural heritage for protection. The latter is defined as areas with outstanding universal value from the aesthetic, scientific and conservation points of view.

**1.6.2.7 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.

**1.6.2.8 World Bank Guidelines on Environmental Assessment {EA} (1991)**

The World Bank requires the execution of an EIA on a proposed industrial activity by a borrower as a pre-requisite for granting any financial assistance in form of loans. 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.

**1.6.2.9 National Oil Spill Detection and Response Agency (NOSDRA), 2006**

The National Oil Spill Detection and Response Agency (NOSDRA) was established in 2006 as the lead Agency in ensuring timely, effective and appropriate response to oil spills, through clean-up and remediation of all impacted sites to all best practical extent.

### 1.6.3 Rainoil Limited/Rainoil Gas Limited HSE Policy

Rainoil Limited/Rainoil Gas Limited not only complies with relevant legislation, but also encourages other initiatives for protecting the health, safety and environment of those affected by its activities. The main focus of the policy is:

i. Has a systematic approach to HSE management designed to ensure compliance with the laws and to achieve continuous performance improvement,

ii. Sets targets for improvement and measures, appraises and reports performance,

iii. Requires contractors to manage HSE in line with this policy,

iv. Zero Harm to People/personnel, Zero Accidents and Zero damage to the Environment.

v. Getting HSE right is the responsibility of everyone, everywhere who works for Rainoil Limited/Rainoil Gas Limited.

vi. Our highest priorities are the health and safety of those who come into contact with our operations, products and facilities, along with the impact we may have upon the environment.

vii. Rainoil Limited/Rainoil Gas Limited encourages the vision to achieve ‘Zero’ in all employees, contractors and partners. This means that we will not be satisfied until we achieve zero incidents in our health, safety and environmental performance.

However, the management system in Rainoil Limited/Rainoil Gas Limited will continually seek to conform to the highest level of HSE principles available. We resolve to implement, maintain and get certified in the occupational health and safety management system and the environmental management system. It will provide a broad-based set of expectations integrated into the following elements of accountability:

- Safety and accident prevention
- Plant and equipment integrity
- Pollution prevention
- Energy conservation

- Personal, occupational and environmental health
- Personal/physical security
- Product stewardship
- Sustainable development

## 1.7 Structure of the Report

The report is presented in eight chapters. Chapter one is an introduction stating the background information about the proponent and the project, and the legal/administrative framework for EIA in Nigeria and international guidelines/convention. The second chapter discusses the project justification and presents the need/value and the envisaged sustainability of the project as well as the project development options considered. Chapter three contains a concise description of the proposed project activities including project scope of work, facilities design data, engineering/detailed design, project management and operations philosophies and the project execution schedule. The fourth chapter describes the existing biophysical, community health and socio-economic baseline status of the project area.

Chapter five presents the potential and associated impacts of the proposed MINI/500MT LPG Blending Plant project at Ibusa, while chapter six proffers mitigation and enhancement measures for adverse and beneficial impacts. Chapter seven describes the environmental management plan that Rainoil Limited/Rainoil Gas Limited proposes to adopt during implementation of the proposed project. Chapter eight presents the conclusion of the report.

# CHAPTER TWO

# PROJECT JUSTIFICATION

## 2.1 Project Background

Nigeria is blessed with abundance of crude oil and associated and non-associated natural gas. The proposed MINI/500MT LPG Blending Plant Project is justified on the basis of the urgent need to address the critical challenges of acute shortage supply and enormous demands for refined petroleum products in Nigeria. Nigeria currently imports about 20 million litres of petroleum products per day, representing about 75% of the total domestic consumption.

Liquefied Petroleum Gas (LPG) has become one of the most important alternative energy sources for domestic, commercial, and industrial applications due to its high thermal efficiency, ease of transportation and storage, versatility, and comparatively cleaner combustion characteristics when compared with traditional biomass fuels such as firewood and charcoal. LPG is extensively used for household cooking, water heating, commercial catering, industrial heating processes, agricultural applications, and as an automotive fuel (autogas). Because it burns more efficiently and produces significantly lower levels of particulate matter, sulphur compounds, and greenhouse gas emissions at the point of use than many conventional solid fuels, LPG contributes to improved indoor air quality, public health, environmental protection, and climate change mitigation.

In Nigeria, the transition towards cleaner energy has placed LPG at the centre of national energy diversification and clean cooking initiatives. Government policies, including the Nigeria Energy Transition Plan (2022) and subsequent national clean cooking programmes, recognise LPG as an important transition fuel for increasing access to affordable modern energy while reducing dependence on firewood, charcoal, and kerosene. (Federal Republic of Nigeria, 2024; Nigeria Energy Transition Plan, 2022) The wider adoption of LPG is expected to contribute to improved public health, reduced deforestation, enhanced energy security, lower household emissions, and achievement of national sustainable development and climate objectives.

Rainoil Limited has emerged as one of Nigeria's leading indigenous downstream energy companies through sustained investment in LPG infrastructure and distribution. The company's LPG business commenced commercial operations in 2020 with the commissioning of an 8,000-metric-tonne LPG storage depot at Ijegun-Egba, Lagos, supported by a fleet of over 40 specialised LPG transport trucks. The business expanded further in 2021 through the establishment of additional retail LPG outlets and customer distribution facilities. In 2023, Rainoil Gas Limited was incorporated as the dedicated LPG subsidiary of the Rainoil Group to strengthen the company's focus on LPG marketing, storage, transportation, retail distribution, and autogas development. By 2026, the company reported an operational network comprising 34 LPG plants, 26 LPG skids, and more than 45 LPG tank trucks, demonstrating significant growth in its national LPG distribution capacity (Rainoil Gas Limited, 2026b). Consequently, the proposed 500 MT inland LPG storage depot and 25 MT cylinder refilling plant at Ibusa, Delta State, represents a strategic extension of Rainoil's long-term investment programme aimed at expanding inland LPG storage capacity, improving regional product availability, strengthening retail distribution, and supporting Nigeria's clean energy transition.

At present, the majority of Nigeria's large LPG import terminals, coastal receiving facilities, and primary bulk storage depots are concentrated in coastal locations, particularly around Lagos and other major seaports. This geographical concentration often creates logistical challenges in supplying inland markets efficiently. The proposed Ibusa facility has therefore been conceived as an inland LPG distribution hub that will receive LPG through specialised pressurised road tankers operating under a virtual pipeline distribution system from coastal terminals, gas processing facilities, and primary storage depots. The LPG will be safely transferred into pressurised storage bullets before being distributed through bulk truck loading and integrated cylinder filling operations to industrial users, commercial customers, LPG marketers, institutions, households, and small businesses across Delta State and neighbouring regions. This approach is expected to improve supply reliability, reduce transportation bottlenecks, shorten delivery times, enhance market accessibility, and strengthen the resilience of Nigeria's downstream LPG supply chain.

The Terms of Reference (ToR) for this Environmental Impact Assessment (EIA) therefore establish the technical scope, study methodology, quality assurance and quality control (QA/QC) procedures, regulatory and institutional framework, stakeholder engagement requirements, environmental and social baseline investigations, impact assessment methodology, mitigation measures, environmental monitoring programme, and reporting requirements necessary to evaluate the potential environmental and social implications of the proposed project. The EIA has been prepared in accordance with the Nigerian Environmental Impact Assessment process and internationally accepted environmental and social management principles to ensure that the project is designed, constructed, operated, and eventually decommissioned in a manner that protects human health, public safety, and the environment while promoting sustainable development.

## 2.2 Project Objectives

The main objectives of the project are as follows:

- To establish a mini 500 MT Liquefied Petroleum Gas (LPG) blending depot integrated with a 25 MT cylinder refilling plant in Delta State.
- To improve the reliability and efficiency of LPG supply to inland markets through a virtual pipeline system using specialised LPG road tankers.
- Expand access to clean, affordable, and modern cooking fuel for households, commercial establishments, institutions, and industrial users, thereby supporting Nigeria's clean energy transition.
- Reduce dependence on traditional biomass fuels and kerosene, contributing to improved public health and reduced environmental degradation.
- Support Rainoil's strategic expansion of its LPG value chain through increased bulk storage capacity, retail distribution, and inland market penetration.
- Promote economic development by creating employment opportunities, stimulating local business activities, and strengthening regional energy security.
- Encourage public consultation and stakeholder participation to raise awareness and integrate community issues into project development.
- Establish a safe and environmentally responsible LPG distribution hub incorporating fire protection, emergency response systems, gas detection, environmental monitoring, and occupational health and safety measures.
- Ensure compliance with applicable Nigerian environmental, petroleum, and occupational health and safety regulations throughout the project lifecycle.
- Minimise potential environmental and social impacts through the implementation of appropriate mitigation measures, continuous monitoring, stakeholder engagement, and the Environmental and Social Management Plan (ESMP).

- To appraise the field and reduce the uncertainties on Hydrocarbon Initially in Place, rock and fluid properties

## 2.3 Need for the Project

The proposed 500 MT Liquefied Petroleum Gas (LPG) blending plant project with an integrated 25 MT cylinder filling plant is driven by the growing need to expand Nigeria's clean energy infrastructure and improve access to reliable LPG supplies in inland communities. Rapid population growth, urbanisation, increasing household energy demand, and government efforts to promote clean cooking have significantly increased the demand for LPG, creating the need for additional storage and distribution facilities beyond existing coastal terminals.

The project is required to strengthen inland LPG supply by reducing dependence on distant coastal storage facilities through the establishment of a strategically located distribution hub at Ibusa, Delta State. The facility will improve product availability, reduce transportation delays and supply interruptions, enhance regional energy security, and support efficient distribution to households, industries, commercial users, and independent LPG marketers.

From an Environmental and Social Management Plan (ESMP) perspective, the project is also needed to ensure that LPG storage and distribution are undertaken using modern engineering standards, effective environmental safeguards, occupational health and safety measures, emergency preparedness systems, stakeholder engagement, and continuous environmental monitoring. The project will contribute to cleaner energy adoption, reduced reliance on firewood, charcoal, and kerosene, lower greenhouse gas emissions at the point of use, employment generation, local economic development, and sustainable growth of Nigeria's downstream LPG sector while ensuring compliance with national regulations and international environmental and social good practice. The project will also provide employment opportunity to those within and around the vicinity of the project site and contribute to the nation’s Gross Domestic Product (GDP).

## 2.4 Benefit of the Project

The proposed 500 MT Liquefied Petroleum Gas (LPG) blending and inland storage depot with an integrated 25 MT cylinder filling plant will deliver significant environmental, social, and economic benefits to Delta State and Nigeria's downstream energy sector. By providing strategically located inland storage and distribution infrastructure, the project will improve the reliability and efficiency of LPG supply, reduce dependence on distant coastal depots, shorten delivery times, and strengthen the resilience of the national LPG supply chain. This will ensure a more stable and accessible supply of LPG to households, commercial establishments, industries, institutions, and independent marketers.

From an environmental perspective, the project will promote the transition from traditional fuels such as firewood, charcoal, and kerosene to cleaner-burning LPG. Increased LPG utilisation is expected to reduce indoor air pollution, lower pressure on forest resources, decrease greenhouse gas emissions at the point of use, and contribute to national clean energy and sustainability objectives.

The project will also generate substantial socio-economic benefits through direct and indirect employment during construction and operation, increased business opportunities for local contractors and suppliers, enhanced government revenue, technology transfer, and improved energy security. Furthermore, the adoption of modern engineering standards, fire protection systems, emergency preparedness, environmental monitoring, and occupational health and safety measures will ensure that operations are conducted responsibly while safeguarding workers, neighbouring communities, and the environment. Collectively, these benefits support sustainable regional development and align with Nigeria's long-term energy transition strategy.

## 2.5 Envisaged Sustainability

The envisaged sustainability of the proposed 500 MT Liquefied Petroleum Gas (LPG) blending and inland storage depot with an integrated 25 MT cylinder filling plant is founded on the principles of environmental protection, economic viability, social responsibility, and operational safety. The project has been conceived to support Nigeria's transition towards cleaner energy by expanding access to LPG as a lower-emission alternative to traditional household fuels such as firewood, charcoal, and kerosene. By improving the availability and affordability of LPG within Delta State and neighbouring inland markets, the project is expected to contribute to reduced deforestation, improved indoor air quality, lower greenhouse gas emissions at the point of use, and enhanced public health outcomes.

From an operational perspective, sustainability will be achieved through the application of internationally accepted engineering standards, preventive maintenance programmes, asset integrity management, emergency preparedness, fire protection systems, gas detection, environmental monitoring, waste minimisation, pollution prevention, and efficient resource utilisation. The proposed closed-system LPG transfer and storage process minimises product losses, reduces fugitive emissions, and enhances process safety throughout the facility's operational life. These measures ensure long-term operational reliability while protecting workers, neighbouring communities, and the surrounding environment.

Social sustainability will be promoted through employment generation, local procurement, stakeholder engagement, community health and safety programmes, staff capacity building, and compliance with environmental, occupational health, and safety regulations. Continuous implementation of the Environmental and Social Management Plan (ESMP), together with periodic environmental audits, performance monitoring, risk assessments, and emergency response planning, will provide mechanisms for continual improvement throughout the project lifecycle. Collectively, these measures ensure that the proposed LPG facility remains economically sustainable, environmentally responsible, socially acceptable, and fully aligned with national clean energy objectives and international Environmental, Social and Governance (ESG) principles. The expected design lifespan of the proposed MINI 500 MT (Metric Tonnes) Liquefied Petroleum Gas (LPG) blending plant project can be sustained for an average of 20 to 30 years, depending soley on regular inspection, preventive maintenance, and strict adherence to safety standards.

### 2.5.1: Economic sustainability

The economic sustainability of the proposed 500 MT Liquefied Petroleum Gas (LPG) blending and inland storage depot with an integrated 25 MT cylinder filling plant is founded on its ability to provide a commercially viable, reliable, and efficient LPG supply system that supports the long-term growth of Nigeria's downstream gas industry. Strategically located at Ibusa, Delta State, the facility will serve as an inland distribution hub, reducing reliance on coastal storage terminals, shortening product delivery distances, lowering logistics costs, and improving the continuity of LPG supply to domestic, commercial, industrial, and institutional consumers. This operational model is expected to enhance market efficiency while supporting the increasing national demand for cleaner energy.

The project is expected to generate sustainable economic benefits through multiple revenue streams, including bulk LPG storage, product blending and transfer, wholesale distribution, cylinder filling services, and retail sales. These activities will strengthen Rainoil's downstream value chain while creating direct employment opportunities for plant operators, engineers, technicians, drivers, safety personnel, and administrative staff, as well as indirect employment for contractors, transporters, suppliers, and local service providers. The project will also stimulate local commerce, improve government revenue through taxes and statutory fees, and encourage private investment in supporting infrastructure and energy services.

Long-term economic sustainability will be reinforced through efficient asset management, preventive maintenance, regulatory compliance, occupational health and safety programmes, environmental protection measures, and implementation of Environmental, Social and Governance (ESG) principles. By expanding access to cleaner cooking fuel, reducing dependence on biomass and kerosene, and supporting Nigeria's energy transition objectives, the project contributes to sustainable economic development while maintaining operational resilience and responsible environmental stewardship throughout its design life.

### 2.5.2: Technical Sustainability

The proposed project is technically sustainable because of the proponent's commitment to adopt best available and technically sound technology. The technical partner who shall be establishing the project is committed to adherence to globally acceptable engineering standards and practice in the project conceptualization, design and establishment. There is also commitment made by the technical partner to operation and maintain the project within a period of time in which local operators and maintenance personnel shall be trained to take over both the operation and maintenance of the 500MT LPG Blending Plant. The partnership agreement also contains both financial and technical support services as measure to guarantee timely and quality project delivery.

### 2.5.3: Social Sustainability

The social sustainability of the proposed 500 MT LPG blending plant is centred on improving access to clean, reliable, and affordable energy while generating lasting socio-economic benefits for host communities and the wider region. The project will create direct and indirect employment opportunities during construction and operation, support local contractors and suppliers, enhance technical skills through workforce training, and stimulate economic activities in Ibusa and neighbouring communities. By increasing the availability of LPG, the project will encourage households and businesses to transition from firewood, charcoal, and kerosene to cleaner cooking fuel, thereby improving public health through reduced indoor air pollution and lowering the health burden associated with smoke exposure. Social sustainability will also be strengthened through stakeholder engagement, grievance management, community health and safety programmes, emergency preparedness, and continuous implementation of the Environmental and Social Management Plan (ESMP), ensuring that community concerns are addressed and project benefits are equitably shared throughout the project lifecycle.

Also, the proposed project is sustainable social-wise because outcome of extensive consultation done with land owners, host community and other stakeholders which were very positive. The consultation and engagement shall continue so as to create excellent working relationship between the proponent and host communities. Likewise, the engagement with government at all levels through the respective regulatory authorities and relevant agencies shall be sustained so as to guarantee social sustainability.

The project proponent is committed to strict adherence to the execution of signed Memorandum of Understanding (MoU), Community Development Agreement (CDA), Corporate Social Responsibility Plan (CSRP) and Livelihood Restoration Action Plan (LRAP). The fact that the project host community approved the establishment of the proposed project is another demonstration of social sustainability.

### 2.5.4: Environmental Sustainability

The environmental sustainability of the proposed project is based on the adoption of cleaner energy technology, pollution prevention, resource efficiency, and environmentally responsible operational practices. The facility will utilise a closed-system LPG storage, blending, and transfer process, minimising fugitive emissions and reducing the risk of environmental contamination. Modern engineering controls, including pressure-rated storage vessels, gas detection systems, emergency shutdown (ESD) facilities, fire protection systems, corrosion control, preventive maintenance, and environmental monitoring programmes, will ensure safe and efficient operations throughout the project lifecycle. The increased availability of LPG will contribute to reduced dependence on biomass fuels, thereby helping to reduce deforestation, lower greenhouse gas emissions at the point of use, improve ambient and indoor air quality, and support Nigeria's clean energy transition objectives. Implementation of the ESMP will ensure continuous environmental monitoring, waste management, spill prevention, emergency response, periodic environmental audits, and regulatory compliance, thereby minimising adverse environmental impacts while promoting sustainable development and adherence to Environmental, Social, and Governance (ESG) principles.

The findings and recommendations of this study would be integrated into all phases of the proposed project lifecycle. Recommendations on the project process, waste management (handling, treatment and disposal) which were developed in line with the environmental regulations, guidelines and standards of the Federal Ministry of Environment (FMEnv) and the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) as well as international best practices would ensure the environmental sustainability of the proposed project.

## 2.6 Project Alternatives

In accordance with the requirements of the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004 and international best practice, alternative project development options were critically evaluated to identify the most technically feasible, economically viable, socially acceptable, and environmentally sustainable means of supplying Liquefied Petroleum Gas (LPG)/propane feedstock to the proposed 500 MT LPG Inland Storage Depot and 25 MT Cylinder Refilling Plant at Ibusa, Delta State.

**Two principal alternatives were considered:**

**Option 1 (Preferred Option):** Transportation of LPG/ propane feedstock from gas production facilities and coastal terminals to the proposed depot using a Virtual Pipeline System (specialized pressurized LPG road tankers).

**Option 2:** Construction of an approximately 85 km dedicated LPG transmission pipeline from the nearest gas production facility in the Kwale axis to the proposed mini depot.

Following a comprehensive technical, economic, social and environmental evaluation, the Virtual Pipeline System was selected as the preferred option.

**Preferred Option: Virtual Pipeline Transportation System (Adopted Option)**

The proposed project will receive LPG through a Virtual Pipeline System, whereby LPG is transported in specially designed pressurized road tankers from existing gas processing facilities and coastal LPG storage terminals to the proposed inland depot. This option eliminates the need for constructing a new dedicated LPG transmission pipeline between the gas source and the project site.

**Technical Considerations**

The Virtual Pipeline System represents a proven, flexible and reliable technology widely adopted for supplying inland LPG facilities where pipeline infrastructure is either unavailable or economically unjustifiable. It offers operational flexibility by enabling multiple supply sources, thereby improving supply reliability and reducing dependence on a single transmission route. The system can be expanded progressively in line with future market demand without major modifications to existing infrastructure, while maintenance requirements are significantly lower than those associated with long-distance pipelines.

**Economic Considerations**

From an economic standpoint, the Virtual Pipeline System offers substantial advantages over pipeline construction. It eliminates the enormous capital investment required for the design, acquisition of Right-of-Way (ROW), pipeline construction, cathodic protection systems, block valve stations, river crossings, monitoring facilities and long-term pipeline maintenance. It also avoids the significant costs associated with land acquisition, compensation for affected landowners, relocation of utilities and settlements, restoration of disturbed areas, and security surveillance along an extensive pipeline corridor. Consequently, the preferred option substantially reduces overall project cost, shortens the implementation schedule, improves investment returns and allows earlier commencement of commercial operations.

**Social Considerations**

The adopted option substantially minimizes disruption to existing communities and socio-economic activities. Since no dedicated pipeline corridor is required, there is no large-scale acquisition of community land or displacement of residential, agricultural or commercial activities. The option therefore avoids involuntary resettlement, loss of livelihoods, disruption of farming activities, destruction of economic trees and conflicts associated with compensation and land ownership. It also preserves existing community infrastructure and minimizes interference with cultural heritage resources, thereby enhancing public acceptance of the project.

**Environmental Considerations**

Environmentally, the Virtual Pipeline System presents the least ecological footprint. The absence of an 85 km pipeline corridor eliminates the need for extensive vegetation clearing, excavation, wetland crossing, forest fragmentation and alteration of natural drainage systems. It significantly reduces habitat destruction, biodiversity loss, soil erosion, sedimentation and long-term landscape modification. Furthermore, it avoids the environmental risks associated with pipeline leaks, corrosion, third-party interference, illegal tapping and prolonged maintenance activities across sensitive ecosystems. Overall, the option aligns with the principles of impact avoidance, resource conservation and sustainable development by limiting environmental disturbance to the project site and existing transportation corridors.

**Alternative Option Not Selected: Construction of an Approximately 85 km LPG Transmission Pipeline**

The alternative considered involved constructing a dedicated LPG transmission pipeline from existing gas processing facilities within the Kwale axis to the proposed inland storage depot. Although pipeline transportation offers continuous product delivery under certain operating conditions, detailed evaluation established that this option is neither technically nor economically justified for the proposed project which is basically a mini depot with a holding total capacity of 500 MT, established on a total land area of approximately one hectares.

Technically, construction of a dedicated pipeline would require complex engineering involving numerous road, river and utility crossings, pressure regulation facilities, cathodic protection systems, block valve stations, pigging facilities, leak detection systems and extensive operational monitoring. The pipeline would also introduce long-term integrity management challenges and increased security requirements.

Economically, this option would entail exceptionally high capital expenditure arising from the acquisition of an approximately 85 km Right-of-Way, payment of compensation for affected properties, crops and economic trees, relocation of utilities, engineering design, pipeline construction, environmental restoration and continuous operation and maintenance. These costs would significantly reduce project viability and extend the investment payback period.

From a social perspective, pipeline construction would require extensive land acquisition across multiple communities, resulting in loss of agricultural land, disruption of livelihoods, restrictions on future land use, possible displacement of settlements and increased potential for community grievances and compensation disputes. Long-term restrictions associated with pipeline Right-of-Way management would also limit future community development along the corridor.

Environmentally, the pipeline option would have considerably greater impacts due to extensive vegetation clearance, habitat fragmentation, disturbance of wetlands, alteration of drainage patterns, soil erosion, increased sediment transport, biodiversity loss and permanent modification of the landscape over the entire pipeline route. Additional environmental risks would include accidental pipeline rupture, product leakage, fire and explosion hazards, and long-term ecological impacts associated with pipeline maintenance and integrity management.

Conclusively, following a comprehensive comparative evaluation, the Virtual Pipeline Transportation System was adopted as the preferred project option because it provides the optimum balance of technical feasibility, economic viability, social acceptability and environmental sustainability. The option eliminates the need for an approximately 85 km LPG transmission pipeline, thereby avoiding extensive land acquisition, ecological disturbance, livelihood disruption, resettlement issues, compensation liabilities and substantial capital expenditure. It also enables faster project implementation, greater operational flexibility and lower environmental impacts, making it the Best Practicable Environmental Option (BPEO) for supplying LPG feedstock to the proposed Rainoil Limited 500 MT Inland Storage Depot and 25 MT Cylinder Refilling Plant at Ibusa, Delta State.

### 2.7 Liquefied Petroleum Gas (LPG) storage Facility

Liquefied Petroleum Gas (LPG) storage constitutes the core operational component of the proposed 500 MT LPG blending and inland storage depot and is fundamental to the safe, efficient, and uninterrupted handling of LPG throughout the project lifecycle. The storage system serves as the interface between product receipt from supply sources and subsequent distribution to bulk consumers and cylinder filling operations. Consequently, the design, construction, operation, and maintenance of the storage facilities must comply with recognised engineering standards, regulatory requirements, and international best practices to ensure the protection of personnel, surrounding communities, and the environment.

Given the flammable and pressurised nature of LPG, careful consideration of alternative storage technologies is an essential component of the Environmental and Social Management Plan (ESMP). The selection of the preferred storage option requires an evaluation of technical feasibility, operational safety, environmental performance, lifecycle cost, ease of maintenance, emergency preparedness, and regulatory compliance. The following section therefore examines the principal LPG storage alternatives applicable to the proposed project and provides the justification for selecting the preferred storage configuration based on engineering, environmental, economic, and safety considerations.

**Option 1 (Preferred):** Above-Ground Pressurised Storage Bullets. This option consists of pressure-rated horizontal steel bullets with a total storage capacity of 500 MT. LPG is received by road tankers through a closed unloading system and stored under pressure before distribution through bulk loading and cylinder filling. It offers lower capital cost, easier inspection and maintenance, rapid leak detection, straightforward emergency response, and compliance with recognised engineering standards. Safety systems include pressure relief valves (PRVs), emergency shutdown (ESD), gas detection, earthing, lightning protection, firewater coverage, and statutory inspection programmes, making it the preferred option for the proposed Ibusa depot.

**Option 2:** Mounded Bullet Storage. Storage bullets are covered with engineered earth fill, providing greater protection against external fire, impact, and weathering. Although this improves safety and security, it requires higher construction costs, specialised civil works, more complex inspection procedures, and additional land preparation, making it less suitable for a medium-capacity inland depot.

**Option 3:** Underground Pressurised Storage Tanks. Underground tanks reduce visual impacts and provide protection from external hazards. However, installation, corrosion protection, leak detection, maintenance, and future inspection are more difficult and expensive than above-ground systems, reducing operational flexibility.

**Option 4:** Refrigerated Atmospheric Storage. Refrigerated storage is generally used for very large import terminals with capacities far exceeding 500 MT. It requires refrigeration systems, higher capital investment, specialised operators, and complex process controls, making it technically and economically unsuitable for the proposed inland LPG blending and distribution facility.

Considering technical performance, environmental protection, operational safety, ease of maintenance, regulatory compliance, lifecycle cost, and suitability for the proposed project, Option 1 (Above-Ground Pressurised Storage Bullets) is the preferred alternative. It provides the optimum balance between safety, operational efficiency, economic viability, and environmental sustainability for the proposed 500 MT LPG blending and inland storage depot.

## 2.8 Facility Layout Concept

Facility layout concept was predicated on the need to segregated incompatible items and zoning of land use. Therefore, three layout concepts were considered as follows:

**Layout Concept A (Preferred): Linear Functional Layout**

The preferred facility layout for the proposed 500 MT LPG blending and inland storage depot with an integrated 25 MT cylinder filling plant is a linear functional layout, in which all process units are arranged sequentially to follow the direction of LPG movement from product receipt to final distribution. Under this concept, LPG road tankers enter through a controlled access gate and weighbridge before proceeding to the unloading bay. LPG is transferred through a closed unloading system into the 500 MT pressurised storage bullets, from where it is conveyed through dedicated pipelines to the bulk loading gantry and the 25 MT cylinder filling plant. Administrative buildings, utilities, firewater facilities, and emergency response infrastructure are located outside the principal hazard area with adequate safety separation distances. This layout minimises vehicle conflicts, reduces unnecessary product handling, facilitates emergency access, improves operational efficiency, and complies with recognised LPG plant design and safety principles. It is therefore considered the most suitable option from technical, environmental, operational, and safety perspectives.

**Layout Concept B: Compact Centralised Layout**

This concept groups the storage vessels, cylinder filling plant, loading facilities, utilities, and administration within a relatively compact footprint to minimise land requirements. Although it reduces site development costs and shortens pipeline lengths, it also decreases separation distances between hazardous and non-hazardous areas, increases congestion, and may complicate emergency response. Consequently, it is less desirable for a 500 MT LPG storage facility where adequate segregation is a fundamental safety requirement.

**Layout Concept C: Segregated Layout**

Under this arrangement, each operational unit—including LPG storage, truck unloading, cylinder filling, bulk loading, utilities, and administration—is physically separated into distinct operational zones connected by pipelines and internal roadways. While this configuration enhances process isolation and future expansion opportunities, it requires a larger land area, longer pipelines, higher infrastructure costs, and increased maintenance requirements. It is therefore more appropriate for large regional terminals than medium-sized inland distribution depots.

**Preferred Layout Concept**

Following an evaluation of technical feasibility, process efficiency, occupational health and safety, emergency preparedness, environmental protection, traffic management, regulatory compliance, lifecycle cost, and future operational requirements, Layout Concept A (Linear Functional Layout) is identified as the preferred option for the proposed project. It provides the safest and most efficient arrangement by ensuring a logical product flow, maintaining adequate separation between hazardous and non-hazardous facilities, facilitating firefighting and emergency evacuation, reducing operational risks, and supporting effective environmental management throughout the project lifecycle. This configuration also allows for future expansion without compromising safety or operational performance.

# CHAPTER THREE

# PROPOSED PROJECT DESCRIPTION

## 3.1 General

This chapter presents the detailed technical description of the Proposed MINI/500MT LPG Blending Plant Ibusa, Oshimili North Local Government Area (LGA) of Delta State, Nigeria. The project work scope, proposed project design overview, operating philosophy as well as the overall implementation schedule for the proposed project are described in this chapter.

Rainoil Limited/Rainoil Gas Limited shall be responsible for the overall project Engineering and Construction as well as Project Management, Pre-commissioning, Commissioning and decommissioning.

## 3.2 Project Work Phase for the Proposed MINI/500MT LPG Blending Plant at Ibusa

This facility shall be a bulk storage and distribution facility for LPG**.** It involves the construction of a MINI/500MT LPG Blending Plant at Ibusa in Oshimili North LGA of Delta State. The proposed project is scheduled for six (6) phases namely:

1. Conceptualization/ Design
2. Site preparation
3. Construction
4. Commissioning
5. Operation
6. Decommission/abandonment

## 3.3 Project Description

The proposed project involves the construction, commissioning, and operation of a modern inland Liquefied Petroleum Gas (LPG) storage, blending, and distribution depot with a total LPG storage capacity of 500 metric tonnes (MT) and an integrated 25 MT cylinder refilling plant at Ibusa, Oshimili North Local Government Area, Delta State. The facility has been conceived as a strategic downstream gas infrastructure project to enhance the storage, handling, and distribution of LPG within Delta State and neighbouring inland markets. It is intended to strengthen the regional LPG supply chain, improve energy security, and support Nigeria's clean cooking and energy transition initiatives through the provision of safe, reliable, and efficient LPG distribution infrastructure.

Unlike coastal LPG import terminals, which receive LPG directly from marine vessels, the proposed facility will operate as an inland distribution depot supplied through a virtual pipeline system. Under this distribution model, LPG will be transported from coastal import terminals, gas processing facilities, and primary bulk storage depots using specialised pressure-rated LPG road tankers. Upon arrival at the depot, each tanker will undergo security clearance, weighbridge verification, documentation, and safety inspection before proceeding to the designated unloading bay. LPG will then be transferred through a fully enclosed and pressure-controlled unloading system into the depot's pressurised storage bullets using dedicated pumps, compressors, and engineered transfer pipelines. The closed-system transfer process minimises product losses, prevents atmospheric releases, reduces environmental risks, and ensures that LPG quality and pressure are maintained throughout storage and handling operations. This virtual pipeline arrangement provides a flexible, reliable, and economically viable means of supplying inland markets where conventional gas pipeline infrastructure is unavailable or not yet developed.

The stored LPG will subsequently be distributed through two integrated operational streams, thereby enabling the facility to serve both wholesale and retail segments of the downstream LPG market.

### 3.3.1. Bulk Distribution Operations

The bulk distribution component of the depot is designed to supply LPG in bulk quantities to a diverse range of commercial customers. Following storage, LPG will be transferred from the storage bullets to dedicated truck loading gantries equipped with loading arms, emergency shutdown systems, overfill protection devices, vapour control arrangements, earthing and bonding facilities, and calibrated metering equipment. Road tankers will be loaded under strict operational procedures before transporting LPG to various categories of end-users, including:

- LPG marketers and wholesale distributors.
- Independent cylinder filling plants.

- Industrial manufacturing facilities.
- Commercial enterprises such as hotels, restaurants, and processing industries.
- Educational institutions, hospitals, and other institutional consumers.
- Large-volume commercial and industrial users across Delta State and neighbouring regions.

The bulk distribution system is expected to improve product availability, reduce transportation distances from coastal depots, minimise supply interruptions, and strengthen the resilience of the regional LPG supply chain.

### 3.3.2. Retail Cylinder Filling Operations

The project also incorporates a 25 MT integrated cylinder refilling plant, which will provide LPG directly to retail consumers through safe and efficient cylinder filling operations. LPG will be transferred from the storage bullets to automated or semi-automated filling manifolds where cylinders will be filled under controlled operating conditions. Each cylinder will undergo visual inspection, weighing, leak testing, valve integrity checks, sealing, and quality assurance verification before being released for distribution or customer collection.

The cylinder filling facility will primarily serve:

- Residential households.
- Small and medium-scale enterprises.
- Restaurants, hotels, and catering establishments.
- Educational institutions.
- Healthcare facilities.
- Commercial businesses.
- Other consumers requiring packaged LPG for domestic and commercial applications.

This retail component will significantly improve public access to clean cooking energy while supporting national efforts to reduce dependence on biomass fuels and kerosene.

### 3.3.3. Major Components of the Proposed Facility

To ensure safe, efficient, and environmentally responsible operations, the proposed depot will comprise the following principal infrastructure:

- **500 MT LPG storage bullets:** Serving as the primary pressurised storage facilities for the receipt and temporary storage of LPG.
- **LPG truck receiving and unloading facilities:** Incorporating dedicated unloading bays, transfer hoses, pumps, compressors, earthing and bonding systems, and leak detection equipment.
- **Bulk truck loading gantries:** For the safe loading of LPG into road tankers destined for wholesale distribution.
- **A 25 MT cylinder filling and handling plant:** Equipped with cylinder inspection, filling, weighing, leak testing, sealing, and storage facilities.
- **LPG transfer pumps and compressors:** Designed to facilitate the efficient movement of LPG throughout the process system.
- **Product pipelines and instrumentation systems:** This includes the pressure, temperature, and level monitoring devices, automated controls, alarms, emergency shutdown systems, and gas detection equipment.
- **Comprehensive fire protection and emergency response systems:** Comprising of firewater storage tanks, fire pumps, hydrants, monitors, extinguishers, emergency communication systems, gas detectors, emergency assembly points, and spill response equipment.
- **Administrative and control buildings:** This houses operational management, engineering offices, control rooms, documentation, personnel facilities, training rooms, and occupational health and safety coordination units.
- **Weighbridge facilities for vehicle weighing:** Product accounting, logistics management, and traffic control.
- **Utility systems and power infrastructure:** Including electrical supply, standby generators, water supply, drainage networks, site lighting, grounding systems, and maintenance services.
- **Security and environmental protection systems:** This comprises of perimeter fencing, controlled access gates, CCTV surveillance, security posts, environmental

monitoring stations, stormwater drainage, waste management facilities, spill containment equipment, and landscaped buffer zones.

Collectively, these facilities will function as an integrated inland LPG distribution hub designed to meet modern engineering, environmental, occupational health and safety, and operational standards. The project has been planned to ensure efficient LPG storage and distribution while minimising environmental impacts through the implementation of robust engineering controls, comprehensive risk management measures, emergency preparedness systems, and continuous environmental monitoring in accordance with the Environmental and Social Management Plan (ESMP).

### 3.4 Engineering and Design Concepts:

The engineering and design philosophy adopted for the proposed 500 MT Liquefied Petroleum Gas (LPG) Blending Plant has been developed to achieve optimum operational efficiency while ensuring compliance with international engineering standards, Nigerian regulatory requirements, and recognized environmental, health and safety (EHS) principles. The design integrates modern LPG storage technology, automated blending systems, process safety engineering, fire protection infrastructure, environmental pollution prevention measures, and adequate spatial separation of hazardous installations. The engineering concept is based on minimizing operational risks throughout the facility life cycle from construction through operation, maintenance, expansion, and eventual decommissioning, while maintaining reliable product quality and environmental sustainability. The project layout, process equipment arrangement, utility systems, emergency response facilities, traffic circulation, and administrative buildings have all been designed as an integrated LPG processing facility with sufficient allowance for future expansion. The engineering drawings further demonstrate that only about 3.55% of the total site area is occupied by built structures, leaving substantial open space for safe operations, emergency access, drainage, landscaping, and future installations.

#### 3.4.1 General Engineering Design

The engineering philosophy of the proposed facility is founded on internationally accepted principles of inherent safety, whereby hazards are minimized during the design stage instead of relying solely on operational controls. This philosophy incorporates the principles of hazard elimination, risk reduction, process containment, explosion prevention, fire protection, equipment redundancy, maintainability, and environmental protection. The entire plant has been designed to facilitate safe receipt of LPG products, blending of propane and butane in specified ratios, temporary storage, truck loading, retail dispensing, and distribution without compromising personnel safety or environmental integrity.

The design adopts a modular arrangement that separates high-risk hydrocarbon processing areas from low-risk administrative and support facilities. Hazardous process units are located within dedicated operational zones with adequate separation distances, while offices, waiting areas and utility buildings are strategically positioned outside the primary process hazard envelope. This arrangement minimizes the potential consequences of accidental fire, explosion or hydrocarbon release and allows emergency response teams unrestricted access during abnormal operating conditions.

In addition, the engineering philosophy emphasizes operational flexibility by incorporating multiple storage vessels, independent pumping systems, dedicated compressor units, separate firewater facilities, and future expansion areas. Such provisions enable uninterrupted plant operation during maintenance activities while enhancing equipment reliability and operational resilience.

### 3.4.2 Site Engineering Layout

The engineering layout has been carefully planned on an approximately 11,277.65 m² site to ensure adequate segregation of operational units while maintaining efficient workflow and emergency accessibility. According to the engineering drawings, the total built-up area occupies approximately 400.69 m², representing only 3.55% of the site area, while over 10,875 m² remains open for traffic circulation, safety clearances, drainage systems, landscaping and future development. The layout incorporates clearly defined functional zones comprising:

- LPG storage and blending area
- Pump houses
- Compressor house
- Firewater system
- Retail dispensing area
- Truck loading facilities

- Administrative complex
- Security facilities
- Driver waiting lounge
- Utility installations
- Internal road network
- Emergency assembly and circulation areas.

The arrangement ensures that hazardous installations remain isolated from occupied buildings while maintaining efficient operational logistics. The wide internal road network provides unrestricted movement of LPG trucks, emergency response vehicles, maintenance equipment and security patrols throughout the facility.

The engineering layout also provides dedicated truck entry and exit routes incorporating weighbridge facilities to minimize traffic congestion while maintaining accurate inventory control. Separate customer access to the retail dispensing area prevents interference between commercial retail activities and industrial LPG truck operations.

### 3.4.3 LPG Storage System Design

The storage system represents the principal engineering component of the proposed facility. The engineering drawings indicate installation of several horizontal pressure vessels comprising propane storage vessels, butane storage vessels, LPG blending vessels, blending/storage vessels, and a finished LPG storage vessel designed to collectively achieve the proposed plant capacity of approximately 500 metric tonnes. The storage arrangement consists of:

- Two 50 MT propane storage vessels
- Two 50 MT butane storage vessels
- Two 50 MT LPG blending vessels
- Two 100 MT blending and storage vessels
- One 30 MT LPG storage vessel

The engineering concept allows propane and butane to be stored separately before controlled blending into specified commercial LPG compositions. This configuration enables accurate product quality control while allowing independent inventory management of each component gas.

Each pressure vessel is designed as a horizontal cylindrical vessel mounted on reinforced concrete saddles capable of supporting operational loads, hydrostatic testing loads and seismic forces where applicable. Vessel materials, wall thicknesses, nozzle arrangements, pressure ratings and fabrication procedures are expected to comply with recognized pressure vessel standards such as ASME Boiler and Pressure Vessel Code Section VIII.

The separation of propane, butane and blended LPG storage significantly reduces cross-contamination risks while improving operational flexibility during maintenance, product changeover and emergency isolation.

### 3.4.4 LPG Blending Process Design

The proposed facility employs a controlled LPG blending process whereby propane and butane are transferred from dedicated storage vessels into blending vessels using specialized transfer pumps and compressors. The engineering concept ensures that blending ratios are achieved accurately according to product specifications before the blended LPG is transferred into storage vessels for truck loading and retail distribution. The blending process incorporates:

- Dedicated propane transfer pumps
- Dedicated butane transfer pumps
- LPG blending vessels
- Blending pump house
- Compressor systems
- Product transfer pipelines
- Storage vessels
- Truck loading facilities

This arrangement minimizes manual intervention and enhances process efficiency through controlled product transfer operations. The process flow also minimizes unnecessary product handling, thereby reducing fugitive emissions, product losses and occupational exposure.

### 3.4.5 Process Equipment Design

The process equipment has been designed to support continuous, reliable, and safe LPG handling operations. Major process equipment includes:

- LPG storage vessels
- Blending vessels
- Transfer pumps
- Compressors
- Pressure relief systems
- Isolation valves
- Instrumentation
- Product pipelines
- Loading connections
- Retail dispensing pumps

Dedicated pump houses have been provided separately for:

- LPG blending pumps
- Propane/butane pumps
- Retail LPG pumps

This segregation minimizes equipment congestion while improving maintenance accessibility and reducing the probability of simultaneous equipment failure. The compressor house provides the required vapour handling capability during LPG transfer operations, pressure balancing and product movement between vessels.

### 3.4.6 Civil and Structural Engineering Design

The civil engineering design provides stable foundations capable of supporting static and dynamic equipment loads throughout the project lifespan. Reinforced concrete foundations are proposed for pressure vessels, pump houses, administrative buildings and utility structures. Structural components have been designed to withstand operational loads, wind loads, equipment vibration and environmental deterioration.

Administrative buildings are constructed using reinforced concrete frames with masonry walling, suspended ceilings, aluminium roofing sheets and vitrified ceramic floor finishes.

Industrial buildings such as pump houses and compressor houses utilize reinforced concrete floors, steel roof trusses and perforated masonry walls to provide natural ventilation while minimizing accumulation of flammable vapours.

Road pavements are designed to accommodate heavy LPG transport vehicles while minimizing dust generation and stormwater erosion. Internal pedestrian walkways are paved separately from vehicle routes to improve personnel safety.

### 3.4.7 Fire Protection Engineering Design

Fire protection forms one of the most critical engineering components of the proposed LPG facility. The engineering drawings indicate installation of a dedicated 300 $m^3$ firewater storage tank supported by a dedicated firewater pump house located adjacent to the operational process area. The fire protection system has been designed to provide:

- Continuous firewater supply
- Rapid firewater distribution
- Emergency firefighting capability
- Cooling water for pressure vessels
- Equipment protection
- Fire brigade support

The dedicated firewater infrastructure operates independently of the domestic water supply, thereby ensuring uninterrupted emergency response capability even during utility failures.

The engineering design also provides adequate equipment spacing to prevent fire escalation between adjacent vessels while facilitating effective firefighting operations.

### 3.4.8 Utility System Design

Supporting utilities have been integrated into the overall engineering design to ensure uninterrupted plant operation. Major utility systems include:

- Firewater supply
- Overhead water storage tank
- Electrical power supply

- Standby generator house
- Instrument air system
- Drainage system
- Septic tank
- Soakaway pit
- Site lighting
- Internal communication systems

The overhead water tank mounted on a 10m steel stanchion supplies domestic water requirements, while the standby generator provides emergency electrical power during public utility outages. Independent utility systems improve plant reliability and operational continuity.

### 3.4.9 Traffic and Operational Logistics Design

The engineering design incorporates a carefully planned traffic management system that separates industrial truck movements from customer vehicles and administrative traffic. Dedicated truck entry, weighbridge operations, loading circulation routes, truck parking areas and exit lanes have been incorporated to eliminate operational conflicts. The layout provides:

- Dedicated truck entry
- Truck driveway
- Weighbridge
- Truck parking bays
- Customer entry and exit
- Retail dispensing area
- Administrative parking

This traffic arrangement minimizes accident potential, reduces vehicle congestion and enhances emergency evacuation capability.

### 3.4.10 Environmental Engineering Design Features

Environmental protection has been integrated into the engineering concept through incorporation of pollution prevention measures aimed at minimizing impacts throughout construction and operation. Key environmental engineering provisions include:

- Large open spaces for natural ventilation
- Landscaped areas
- Surface drainage systems
- Septic tank and soakaway facilities
- Controlled stormwater management
- Impervious process surfaces
- Controlled waste handling areas
- Spill containment around process equipment
- Separation of hazardous and non-hazardous operational areas

The engineering layout further minimizes unnecessary vegetation clearance while preserving significant portions of the site for landscaping and future environmental enhancement.

### 3.4.11 Provision for Future Expansion

One notable engineering feature of the proposed facility is the reservation of dedicated space for future expansion. The engineering drawings clearly indicate an area labelled Future Installation, allowing the proponent to increase storage capacity or install additional process units without major disruption to existing operations.

This sustainable design minimizes future construction impacts while ensuring long-term operational flexibility as LPG demand increases within Delta State and neighbouring regions.

### 3.4.12 Engineering Design Compliance

The general engineering concept reflects internationally recognized best practices for LPG facilities by incorporating process safety, equipment redundancy, environmental protection, emergency preparedness, operational efficiency and maintainability into a single integrated design. The facility layout, pressure vessel arrangement, fire protection infrastructure, utility systems, traffic circulation and environmental safeguards collectively demonstrate an engineering philosophy consistent with the objectives of an Environmental and Social Management Plan (ESMP), namely minimizing environmental impacts, protecting workers and neighbouring communities, ensuring regulatory compliance and promoting sustainable project operation throughout the facility life cycle.

### 3.5 Advisory Only - On-Site Services:

The proposed 500 MT Liquefied Petroleum Gas (LPG) Blending Plant incorporates several on-site support services that are essential for the safe construction, commissioning, operation and maintenance of the facility. Although these services are not directly involved in the LPG blending process, they provide the administrative, utility, emergency response, security and welfare functions required for efficient plant performance and regulatory compliance. The engineering layout includes an administrative building, gate house, weighbridge office, truck drivers' waiting lounge, firewater pump house, compressor house, utility buildings, sanitary facilities, internal roads, parking areas and emergency access routes, all strategically positioned to support uninterrupted operations while maintaining safe separation from hazardous process areas.

#### 3.5.1 Administrative and Operational Support Services

The administration building serves as the central operational hub and houses the plant manager, accounts office, control panel room, safety office, cashier's office, conference room, reception, operators' locker room, store, sanitary facilities and support offices. The control room provides centralized monitoring of LPG transfer, blending and storage operations through instrumentation and alarm systems, enabling prompt operational decision-making and emergency response.

#### 3.5.2 Security Services

Security services will be provided through a dedicated gate house operating on a 24-hour basis. Security personnel will control access, inspect vehicles, verify deliveries, maintain visitor records and coordinate emergency access during incidents. Routine patrols will also protect critical process equipment and storage facilities.

### 3.5.3 Fire Protection and Emergency Services

The facility includes a dedicated 300 $m^3$ firewater tank, firewater pump house and emergency access roads. These facilities provide independent firefighting capability for storage vessels, loading areas and process equipment. Emergency response personnel will receive specialized LPG fire and spill response training in accordance with recognized industry practice.

### 3.5.4 Utility and Maintenance Services

Utility services include electrical power supply, standby generator, overhead water tank, compressors, LPG transfer pumps, drainage systems, septic tanks and communication facilities. Preventive maintenance will be undertaken by mechanical, electrical and instrumentation technicians to ensure equipment integrity and minimize operational downtime.

### 3.5.5 Welfare Services

Personnel welfare facilities include the truck drivers' waiting lounge with canteen, staff toilets, changing rooms, locker facilities, potable water supply and designated parking areas. These facilities improve employee welfare, occupational health and operational efficiency.

### 3.5.6 Estimated Construction Man-Hours and Personnel

The construction phase is expected to require a multidisciplinary workforce comprising approximately 80-120 personnel at peak construction. The estimated direct labour requirement is approximately 140,000-180,000 man-hours over an anticipated construction period of 8-10 months. This estimate includes civil, structural, mechanical, piping, electrical, instrumentation, architectural and commissioning activities typical of a 500 MT LPG blending facility.

The anticipated construction workforce includes (**Table 3.1**):

**Table 3.1: Estimated Personnel Category**

| Personnel Category | Estimated Number |
|---|---|
| Project Manager | 1 |
| Construction Manager | 1 |
| Site Engineers (Civil, Mechanical, Electrical) | 6–8 |
| HSE Manager/Officers | 3–5 |
| QA/QC Engineers | 2–3 |
| Surveyors | 2 |
| Welders/Fabricators | 15–20 |
| Pipe Fitters | 12–18 |
| Civil Construction Workers | 20–30 |
| Steel Fixers/Formworkers | 10–15 |
| Electricians | 8–12 |
| Instrument Technicians | 5–8 |
| Equipment Operators | 6–8 |
| Drivers | 6–10 |
| Security Personnel | 8–12 |
| Administrative/Store Personnel | 4–8 |
| General Labourers | 20–30 |

Following commissioning, the operational workforce is expected to comprise approximately 30–45 permanent personnel, including plant operators, maintenance technicians, laboratory support (where applicable), HSE personnel, security officers, administrative staff and management.

### 3.5.7 Site Development Requirements

Site development for the proposed LPG blending plant will involve comprehensive civil, structural, and environmental works to prepare the approximately 11,277.65 m² project site for safe industrial operations. The engineering drawings indicate that only 3.55% of the site will be occupied by permanent structures, leaving substantial open areas for internal circulation, emergency access, drainage, landscaping and future expansion.

**Site Preparation**

Development activities will include vegetation clearing, grading, earthworks, excavation, foundation preparation and construction of reinforced concrete bases for pressure vessels, buildings and utility structures. Drainage channels will be installed to control stormwater runoff and minimize erosion.

**Civil and Structural Infrastructure**

Civil works comprise construction of the administration building, gate house, weighbridge office, pump houses, compressor house, firewater facilities, generator house, truck drivers' lounge, storage vessel foundations, retaining structures, internal roads and paved walkways. Structural works will utilize reinforced concrete foundations and steel structural members designed for industrial loading conditions.

**Roads and Traffic Facilities**

The development includes dedicated truck entry and exit points, weighbridge facilities, truck parking bays, customer parking, loading areas and internal circulation roads designed to safely accommodate LPG transport vehicles while ensuring emergency accessibility.

**Utility Infrastructure**

Site utilities include electrical distribution systems, standby power generation, overhead water storage, firewater supply, communications, drainage, septic tanks, soakaway pits and site lighting. These systems provide reliable operational support under both normal and emergency conditions.

**Environmental Protection Measures**

Environmental development requirements include stormwater drainage, erosion control, wastewater management, landscaped areas, waste collection points and designated spill control zones. Approximately 626.61 $m^2$ of the site has been allocated for landscaping to enhance aesthetics, reduce dust generation, and improve environmental quality.

**Future Expansion**

The engineering layout reserves a Future Installation area for additional storage vessels or process equipment, enabling future capacity expansion without major modification to the existing plant layout. This provision enhances long-term operational flexibility and sustainable development.

## 3.6 Commissioning and Demobilization

### 3.6.1 Commissioning

The Commissioning procedure shall be in line with Rainoil Limited/Rainoil Gas Limited and general technical specification. Before commissioning, pre-start up review and all relevant checklists shall be signed off before commencing these activities. At the end of commissioning, Rainoil Limited/Rainoil Gas Limited shall commence full operation.

### 3.6.2 Demobilization

At the end of the project lifespan (average 30 years), facilities may be abandoned and decommissioned in line with FMEnv/NMDPRA requirements for decommissioning/abandonment of LPG Plant and Rainoil Limited/Rainoil Gas Limited site decommissioning/abandonment philosophy.

## 3.7 Project Schedule

The Project is as schedule is as shown in the table below:

| Activity | 2026 | | | | 2027 |
|---|---|---|---|---|---|
| | Q2 | Q3 | Q4 | Q1 | Q2 |
| ESMP Studies/Approval | | | | | |
| Procurement and mobilization | | | | | |
| Site preparation and civil works | | | | | |
| Mechanical, electrical and instrumentation installation | | | | | |
| Commissioning and performance testing | | | | | |

# CHAPTER FOUR

## Environmental Baseline Study of the Proposed Project Area

### 4.1 General

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

### 4.2 Methodology of Study

A multi-disciplinary approach was employed in the acquisition of environmental conditions data of the proposed project area. The environmental condition for the proposed 500MT LPG at Ibusa, Oshimili North LGA was obtained through desktop research, field observation, sampling and measurements as well as laboratory analyses of biological, chemical and physical characteristics of sampled environmental components.

#### 4.2.1 Desktop Research

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

#### 4.2.2 Reconnaissance Field Visit

A field reconnaissance visit was carried out to project area and host communities by the ESMP study team lead on to firm up sampling strategies, identifies representatives of the host communities that will join the team as local labour and identify options for logistic planning in order to have a hitch-free field campaign. The consultation process that has started at this reconnaissance visit will be maintained throughout the various phases of the study and project execution.

### 4.2.3 Samples Collection Methodology and Preservation

The field data gathering activities for the one season ESMP study was carried out between $26^{th}$ and $27^{th}$ June, 2026. However, in a bid to capture sufficient environmental data to enable a good impact assessment afterwards; Purposive Sampling Technique was adopted to obtain baseline data on the specific environment of the study area and sampling strategy that will allow for good coverage of the study area was adopted (**See Figure 4.1**).

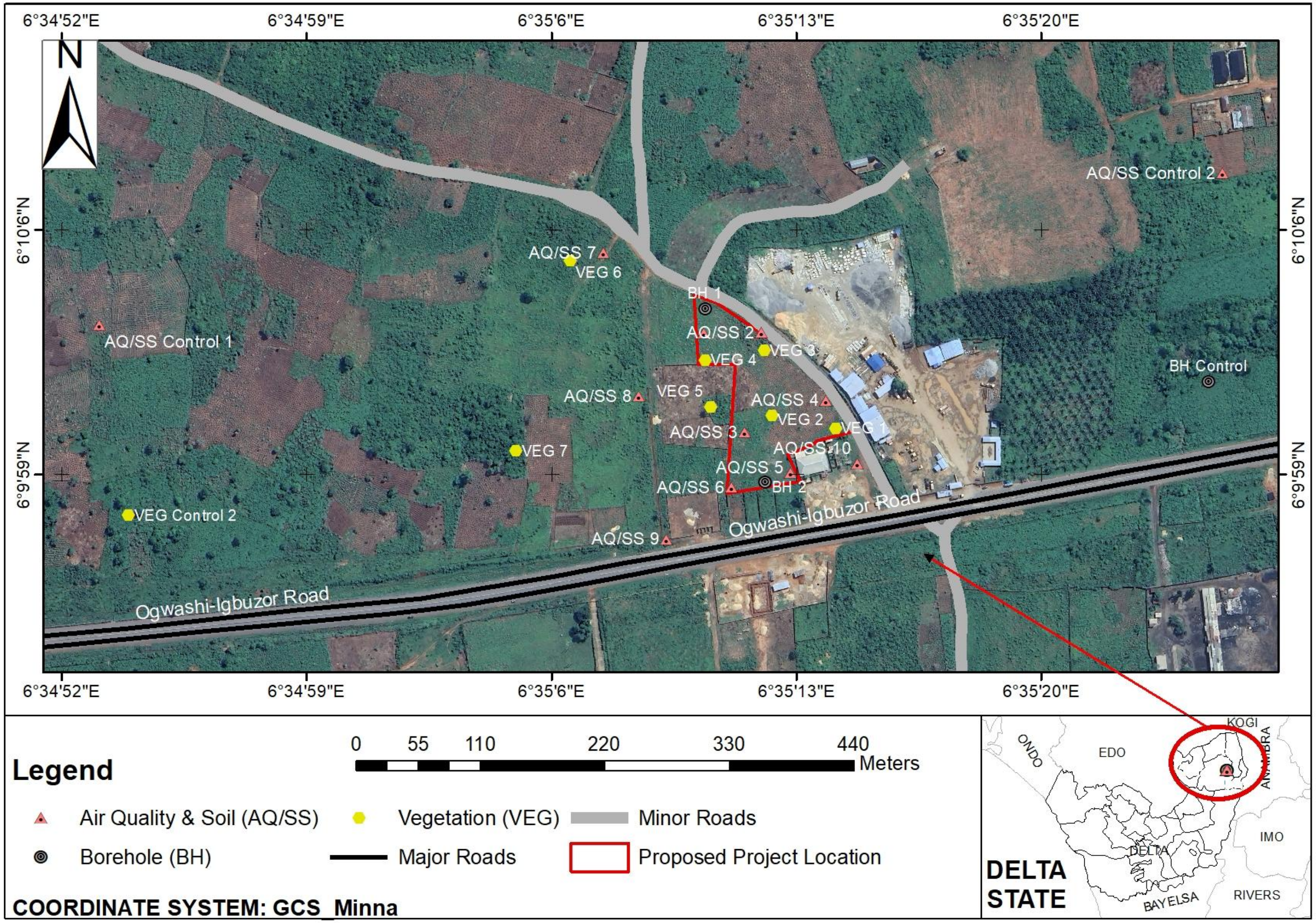



**Figure 4.1: Map of the study area showing sampling stations**

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

i. Soil sampling/biodiversity/vegetation studies team
ii. Socio-economics/Health Risks studies team,
iii. Geology/hydrogeology studies team and
iv. Surface water /Sediment studies team.

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

***Geographical Positioning***

Positioning at each sampling station during the fieldwork activities was achieved with the aid of a handheld *Garmin* Global Positioning System (GPS) V, (model CZ 99052-20). At each sampling station, coordinates at which sampling actually took place were documented.

### 4.2.4 Laboratory Analysis

After the fieldwork exercises, study samples were transported to Tudaka Analytical Nig. Limited, Warri, an accredited laboratory by DPR (now NMDPRA) and FMEnv for necessary and adequate analyses. Samples were analyzed using standard analytical methods (EGASPIN, 2018; APHA, 1998). The synoptic descriptions of the laboratory analytical methods and procedures employed for the various physical, chemical and biological parameters as well as the detection limits of these parameters are documented in this report. Also documented are synopsis of the QHSE plan adopted in both field data collection and laboratory analysis**.** Detailed methodologies for laboratory analysis of field samples are presented in **Appendix.**

## 4.3 Existing Environmental Conditions of the Proposed Project Area

### 4.3.1 Ambient Air Quality

The ambient air quality is considered as the broader state of the atmosphere above 5 meters from ground level in each environment. There are combinations of factors that can cause high concentration of gaseous pollution within various communities. The meteorological conditions and cumulatively local emission sources often define the ambient air quality whether the gases are of high or low emission concentrations.

Air monitoring is of critical importance for characterizing health risks, formulating cost-effective abatement strategies, setting, and enforcing appropriate air quality standards and for healthy urban planning (EIA NOGaPS Report, 2019). The following Air Pollution emission parameters were taken into consideration and monitored during field data gathering exercise, in line with the Terms of Reference $SO_x$, CO, $H_2S$, VOC, $NO_x$, $CO_2$, $NH_3$, $PM_{2.5}$, and $PM_{10}$. A total 10 sample points and 2 controls were considered within and outside the project site at Ibusa community. The following pollutant gases were considered.

- Ammonia ($NH_3$)
- Carbon Monoxide (CO)
- Carbon dioxide ($CO_2$)
- Hydrogen Sulphide ($H_2S$)
- Oxides of Nitrogen ($NO_x$)
- Oxides of Sulphur ($SO_x$)
- Particulate Matter (PM2.5, and PM10)
- Volatile Organic compounds (VOC)

To effectively assess the air quality in the study area, comparative data on the ambient air pollution levels and their spatial and temporal variability were considered, the mean field air quality data computation is as presented in **Tables 4.1**. The study area is about 11277.650 $m^2$ of the project site.

The objective of air sampling and analysis is the adequately use of the gaseous pollutants' characteristics within the area of interest, to determine its baseline, pre-project, during construction and post commissioning of the project.

**Table 4.1: Ambient Air Quality Comparative Analyses Data for the Proposed MINI 500MT Blending Plant ESMP at Ibusa, Oshimili North LGA of Delta State, Nigeria**

| PARAMETER | LATITUDE | LONGITUDE | $SO_X$ ($mg/m^3$) | $NO_X$ ($mg/m^3$) | CO ($mg/m^3$) | $NH_3$ ($mg/m^3$) | $H_2S$ ($mg/m^3$) | VOC ($mg/m^3$) | $CO_2$ (ppm) | $PM_{2.5}$ ($\mu g/m^3$) | $PM_{10}$ ($\mu g/m^3$) | $SO_2$ ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **POINT 1** | 6°10'2.75"N | 6°35'10.47"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 684 | 0.018 | 0.036 | <0.001 |
| **POINT 2** | 6°10'3.06"N | 6°35'11.99"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 693 | 0.021 | 0.04 | <0.001 |
| **POINT 3** | 6°10'0.21"N | 6°35'11.51"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 702 | 0.016 | 0.031 | <0.001 |
| **POINT 4** | 6°10'0.55"N | 6°35'14.04"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 719 | 0.019 | 0.038 | <0.001 |
| **POINT 5** | 6° 9'59.05"N | 6°35'12.82"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 752 | 0.023 | 0.045 | <0.001 |
| **POINT 6** | 6° 9'58.74"N | 6°35'11.57"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 749 | 0.02 | 0.041 | <0.001 |
| **POINT 7** | 6°10'5.34"N | 6°35'7.48"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 756 | 0.025 | 0.048 | <0.001 |
| **POINT 8** | 6°10'1.24"N | 6°35'8.47"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 696 | 0.022 | 0.044 | <0.001 |
| **POINT 9** | 6° 9'57.16"N | 6°35'9.26"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 754 | 0.024 | 0.046 | <0.001 |
| **POINT 10** | 6° 9'59.31"N | 6°35'14.73"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 770 | 0.025 | 0.054 | <0.001 |
| **CONTROL 1** | 6°10'3.29"N | 6°34'53.07"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 730 | 0.017 | 0.034 | <0.001 |
| **CONTROL 2** | 6°10'7.62"N | 6°35'25.16"E | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 721 | 0.019 | 0.038 | <0.001 |

Source: Field Data from Proposed ESMP Rainoil 500MT LPG Blending Plant Project Site, 2026

Moreover, the characterisation is usually based on the intended data and this use includes the following:

- Checking adherence to air quality standards,
- Observing pollution trends and relating any changes to emission variations,
- Developing and evaluating abatement strategies,
- Assessing health effects or plant damage which may have arisen from exposure to air pollutants (this will normally include geographic and temporal distributions),
- Developing and applying a warning system for prevention of undesired air pollution episodes and developing and testing pollutant diffusion models.

The major sources of air emissions and noise in the area are from motorcycles, and vehicular movements around the proposed project site. The detailed result analyses of the ambient air quality/noise levels measurements at the ten (10) designated points and two (2) control points in the area are presented in **Figures 4.2 - 4.12**.

- ***Suspended Particulate Matter (SPM)***

Suspended Particulate Matter (SPM) are finely divided solids or liquids with aerodynamic diameter airborne $PM_{10}$ (atmospheric dynamics equivalent diameter ≤ 10µm) and $PM_{2.5.}$ (Atmospheric dynamics equivalent diameter ≤ 0.5µm) derived mainly from combustion related sources that may be dispersed through the air from combustion processes, industrial activities or natural sources, such as dust, fumes, mist, and smoke. The size, chemical composition, and other physical and biological properties of particles vary with location and time.

**Table 4.2: Particulate Matter Data**

| **Gases** | **Point 1** | **Point 2** | **Point 3** | **Point 4** | **Point 5** | **Point 6** | **Point 7** | **Point 8** | **Point 9** | **Point 10** | **Control 1** | **Control 2** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ (µg/m$^3$) | 0.018 | 0.021 | 0.016 | 0.019 | 0.023 | 0.02 | 0.025 | 0.022 | 0.024 | 0.025 | 0.017 | 0.019 |
| $PM_{10}$ (µg/m$^3$) | 0.036 | 0.04 | 0.031 | 0.038 | 0.045 | 0.041 | 0.048 | 0.044 | 0.046 | 0.054 | 0.034 | 0.038 |

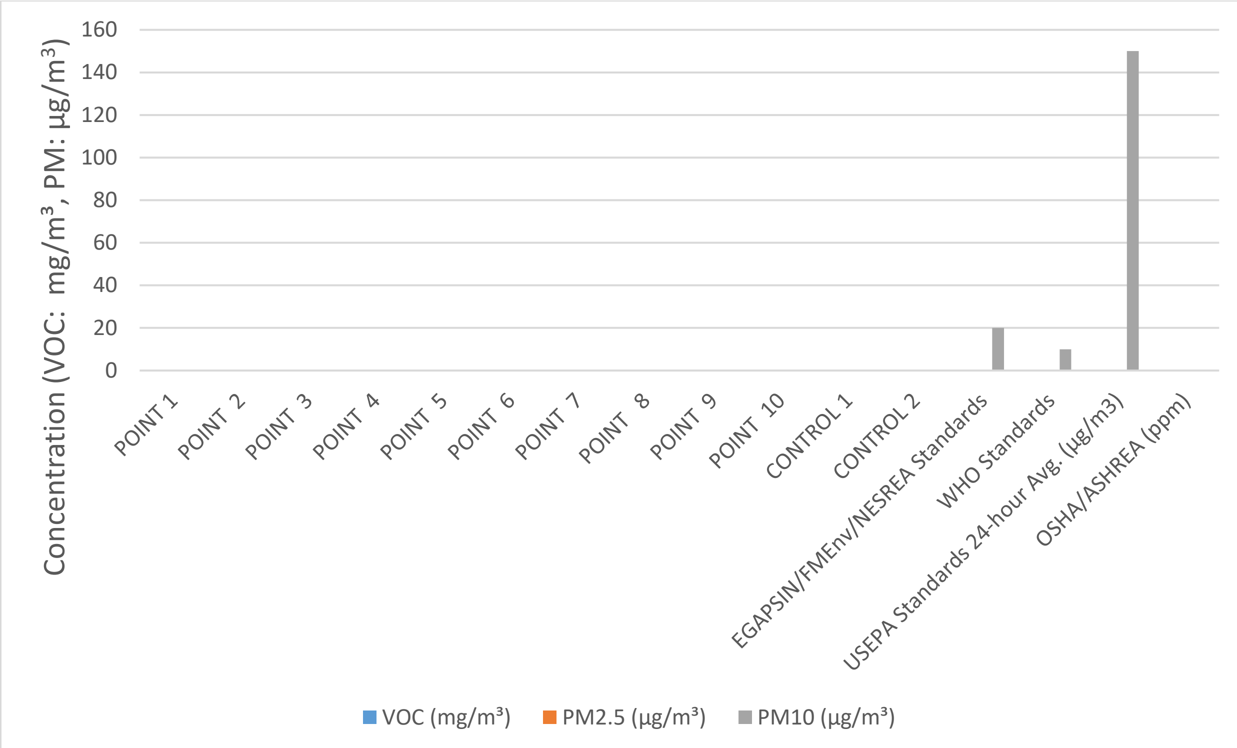
Source: Field Data from Proposed ESMP Rainoil 500MT LPG Blending Plant Project Site, 2026

- **Fine Particulate Matter ($PM_{2.5}$)**

The Particulate Matter ($PM_{2.5}$) field data ranged from 0.016 and 0.025 µg/m³, with an average concentration of 0.0213 ± 0.003 µg/m³. These concentrations are significantly lower than the WHO guideline value of 10 µg/m³ and the USEPA 24-hour standard of 35 µg/m³, demonstrating exceptional ambient air quality. However, the control points data value was 0.017 µg/m³ and 0.019 µg/m³ for Control Point 1 and Control Point 2 respectively **(Table 4.2)**. Fine particulate matter is one of the most important indicators of respiratory health risk because of its ability to penetrate deep into the lungs. The extremely low concentrations therefore indicate minimal health risk to nearby receptors.

- **Coarse Particulate Matter ($PM_{10}$)**

The Particulate Matter for $PM_{10}$ values ranged from 0.031 µg/m³ (Point 3) to 0.054 µg/m³ (Point 10) while the control values were 0.034 µg/m³ (control 1) and 0.038 µg/m³ (Control 2) as shown in **Table 4.2**. The observed values for $PM_{10}$ were below the EGAPSIN/FMEnv/NESREA Standards (20 µg/m³), WHO standards (10 µg/m³) and USEPA Standards 24-hour Avg. (150 µg/m³) see **Figure 4.2**. Similar assessments around natural gas facilities have shown that particulate concentrations typically increase during construction and operational activities if appropriate mitigation measures are not implemented.




**Figures 4.2: VOC, PM2.5 and PM10 Mean Data at Proposed Rainoil 500MT LPG Blending Plant**

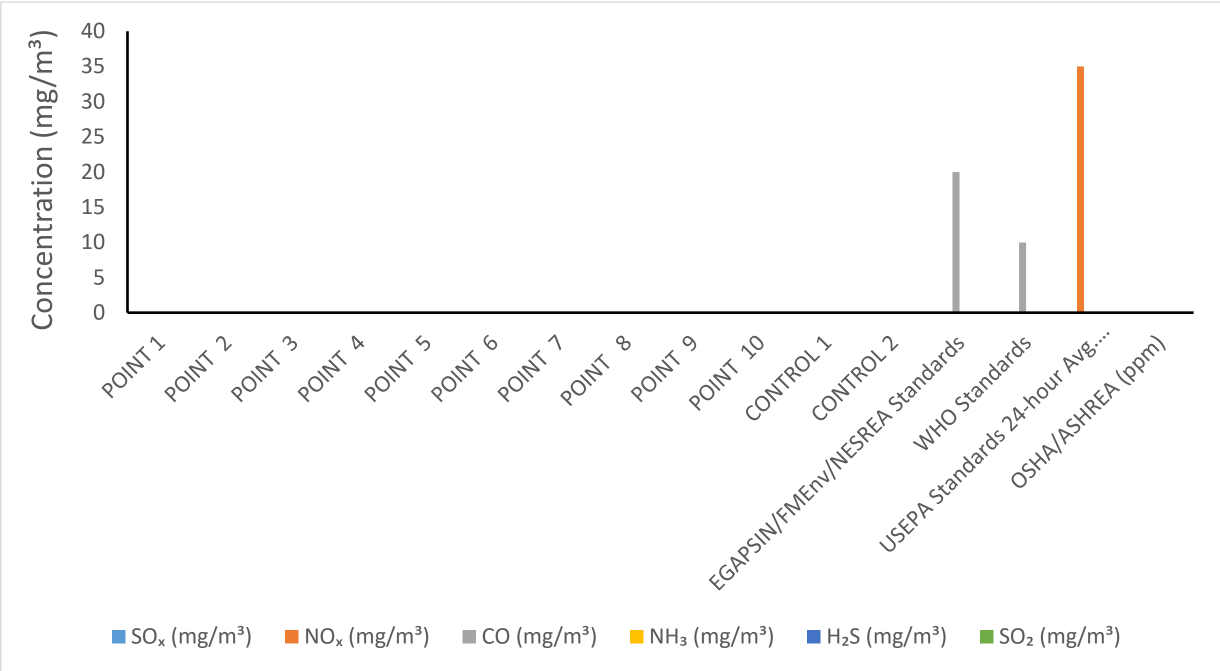
- **Volatile Organic Compounds (VOCs)**

Volatile Organic Compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate, which participates in atmospheric photochemical reactions. VOCs form ground level Ozone by "reacting" with sources of oxygen molecules such as nitrogen oxides (NOx), and carbon monoxide (CO) in the atmosphere in the presence of sunlight (USEPA, 2019).

The measured VOC concentrations were below 0.001 mg/m³ at all sampling locations **(see Table 4.2 and Figure 4.2)**. VOCs are important atmospheric pollutants associated with fuel handling, solvent use and hydrocarbon processing. Their non-detectable concentrations indicate that hydrocarbon vapour emissions are presently insignificant within the proposed project area. This provides an important benchmark because VOC monitoring will become one of the critical environmental performance indicators once LPG storage and blending operations commence.

- **Short Live Pollutant Gases**

Pollutant gases ($SO_2$, $NO_x$, $H_2S$ and CO) emissions were not detected in the proposed project area at the time of sampling for the Environmental Baseline Study (EBS) and were below equipment detection limit of <0.001. The results recorded (<0.001µg/m$^3$) were consistent with the same values at the control points (<0.001µg/m$^3$) and below their respective NMDPRA and FMENV regulatory limits as presented in **Table 4.1**




**Figures 4.3: $SO_x$, $NO_x$, CO, $NH_3$, $H_2S$, and $SO_2$ (mg/m³) Mean Data at Proposed Rainoil 500MT LPG Blending Plant**

- **Carbon monoxide (CO)**

The pollutant gase, Carbon monoxide (CO) concentrations obtained were also below 0.001 mg/m³ at all monitoring stations. Carbon monoxide is an important indicator of incomplete combustion from vehicles, generators and industrial equipment. The extremely low concentrations indicate that combustion activities within the vicinity of the proposed project are negligible. Consequently, current atmospheric conditions pose no health concern with respect to carbon monoxide exposure. **Table 4.3.**

- **Ammonia ($NH_3$)**

Ambient ammonia concentrations remained below 0.001 mg/m³ throughout the study area. The absence of measurable ammonia indicates that agricultural activities, fertilizer storage facilities and industrial chemical processes currently exert little or no influence on the local atmospheric environment

- **Sulphur dioxide ($SO_2$)**

This gas has the smell of burnt matches and it is categorised as a toxic gas. It is also produced by the burning of fossil fuels contaminated with sulphur compounds, if in high concentration and inhaled, it could affect human respiratory system, particularly lung function, tract infection and eyes irritation. The emission values of Sulphur dioxide concentrations were consistently below 0.001 mg/m³ across all sampling stations. These values are considerably lower than national and international ambient air quality guideline values, indicating excellent compliance with FMEnv, EGASPIN and WHO standards. The absence of measurable $SO_2$ emissions confirms that the project environment is not presently influenced by petroleum combustion processes, industrial boilers or other sulphur-generating activities, see **Table 4.1** and **Figures 4.3**.

- **Sulphur Oxides ($SO_x$)**

Sulphur oxide concentrations at all monitoring locations were reported as <0.001 mg/m³, indicating that the concentrations were below the detection capability of the monitoring equipment. This finding suggests that there are currently no significant sulphur-emitting industrial activities or heavy fuel combustion sources within the project area. Sulphur oxides are important atmospheric pollutants because prolonged exposure contributes to acid deposition, respiratory irritation and ecosystem degradation. The absence of detectable $SO_x$ therefore demonstrates a favourable atmospheric environment prior to project implementation. Studies conducted around gas processing and industrial facilities have similarly reported elevated $SO_2$ concentrations where combustion emissions are significant, unlike the present study which reflects pristine baseline conditions.

- **Nitrogen dioxide ($NO_x$)**

Nitrogen dioxide is one of the groups of highly reactive gases known as oxides of nitrogen, composed of nitrogen and oxygen. It is a major contributor to atmospheric pollution and to the chemical reaction that makes ozone. It primarily gets in the air from the burning of fuel, when in high concentration and inhaled can result in heart failure and sometimes death in severe cases.

The mean concentrations value of $NO_X$ within the proposed project area was below the analytical detection limit (<0.001 mg/m³) at all monitoring locations. Nitrogen oxides are generally produced through high-temperature combustion processes associated with vehicular traffic, power generation and industrial operations. Their absence indicates minimal combustion-related activities within the study area and reflects favourable atmospheric conditions. Previous studies around industrialized areas in Nigeria have reported substantially higher $NO_2$ concentrations associated with urban and industrial emissions, emphasizing the comparatively clean baseline condition observed at the proposed project site., see **Table 4.1** and **Figures 4.3.**

- **Hydrogen Sulphide ($H_2S$)**

It is evident around decomposed refuse dumpsites in Nigeria. This gas is said to account for about 9.5% of all United States greenhouse gas emissions from human activities. Hydrogen sulphide concentrations were below 0.001 mg/m³ at all monitoring locations indicating excellent compliance with FMEnv, EGASPIN and WHO standards. This observation is particularly significant for an LPG project because $H_2S$ is commonly associated with hydrocarbon production, gas processing and petroleum storage facilities. The results indicate that the proposed project site presently experiences no detectable hydrogen sulphide contamination and therefore provides an excellent environmental baseline for future operational monitoring. See **Table 4.1 and Figure 4.3**.

#### 4.3.1.1 Climate Change - Greenhouse Gases ($CO_2$) Parameters

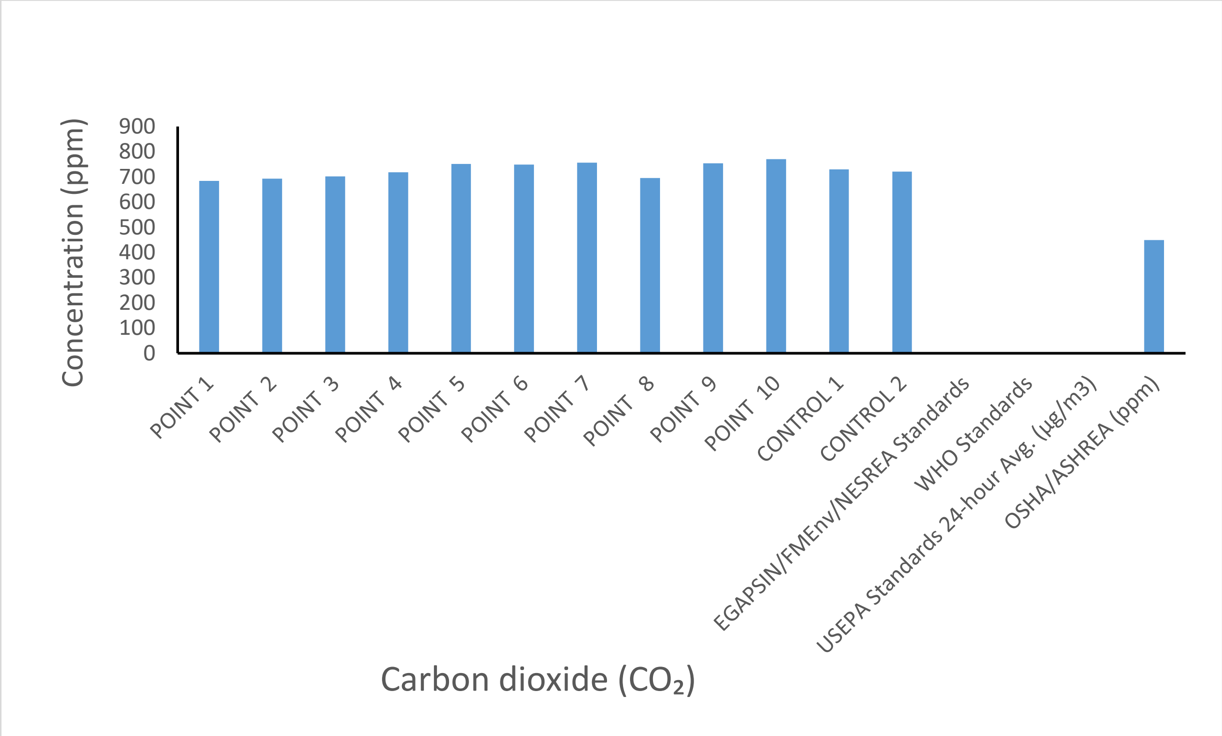
- **Carbon dioxide ($CO_2$)**

Carbon dioxide is a major Greenhous Gas which is contributing to Climate Change. It is also naturally present in outdoor ambient air (about 0.03 per cent) and indoor with high percentage or part per million (PPM) when the room is enclosed. It is absorbed by plants in photosynthesis.

It is an important pollutant gas considering the current global concern on greenhouse gas emission. The increase of Greenhouse Gas (GHG) emission is a global concern and Carbon Dioxide ($CO_2$) is a part of the GHG family. It is a known to be colourless, odourless gas produced by burning carbon and organic compounds and by respiration.

The Mauna Loa Observatory in Hawaii noted in August 2016 that the mean monthly average measurement of $CO_2$ increased from 398.93 ppm in 2015 to 402.25 ppm a year later (United

States Earth System Research Laboratory (ESRL) and National Oceanic and Atmospheric Administration (NOAA), 2016; Okobia., et al 2017; Okobia and Abdul, 2020)).

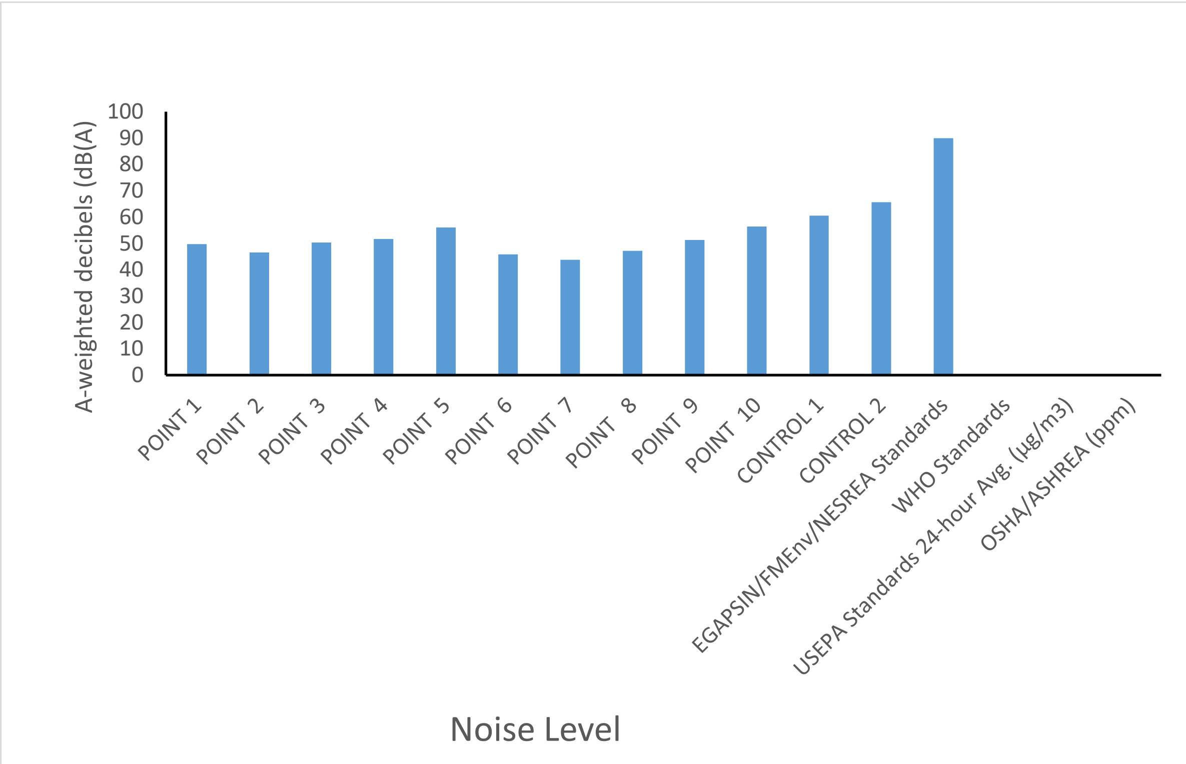



**Figures 4.4: $CO_2$ (mg/m³) Mean Data at Proposed Rainoil 500MT LPG Blending Plant**

The Carbon dioxide concentrations within the Proposed Project Area ranged from 684 to 770 ppm, with a mean concentration value of 727.5 ± 31.94 ppm. The observed concentrations represent normal atmospheric background conditions and show only minor spatial variation across the monitoring locations. The slightly elevated values recorded at some locations may reflect localized influences such as soil respiration, vegetation density and limited human activities rather than industrial emissions (see **Table 4.1 and Figure 4.4)**. However, the $CO_2$ level may increase during construction works but should be controlled as it will lead to climate effects (Okobia and Abdul, 2020).

#### 4.3.1.2 Ambient Noise Level

Benetech Digital sound meter GM1356 model was used to measure noise levels at all locations. The equipment measures noise via microphone probe that generates signals appropriately proportional to sound waves. The sensor of the sound level meter was directed upwards and an average reading over a period of two minutes was taken to be the Noise-level at each point with the measuring range: calibration instrument standard 94dB(A) at 1KHZ, the time weighting is FAST; Level range is 60 to 10dB(A).




**Figures 4.5: Noise Levels (dB(A)) Mean Data at Proposed Rainoil 500MT LPG Blending Plant**

The ambient noise levels recorded across the monitoring stations ranged from 43.8 to 65.7 dB(A), with an overall mean of 52.12±6.49 dB(A). The noise levels measured within the project area (43.8–56.4 dB(A)) and at the control stations (60.6–65.7 dB(A)) were all below the FMEnv/EGASPIN/NESREA daytime limit of 90 dB(A), indicating that the baseline acoustic environment is acceptable for the proposed development and does not currently pose significant nuisance or health concerns (see **Figure 4.5).**

### 4.3.2. Climate Meteorology

#### 4.3.1.1 Temperature

The hot season lasts for 2.6 months, from January 26 to April 13, with an average daily high temperature above 30°C. The hottest month of the year in Ogwashi-Uku is April, with an average high of 30°C and low of 23°C. The cool season lasts for 4.1 months, from June 18 to October 22, with an average daily high temperature below 28°C. The coldest month of the year in Ogwashi-Uku is January, with an average low of 19°C and high of 30°C as shown in **Figure 4.6**.

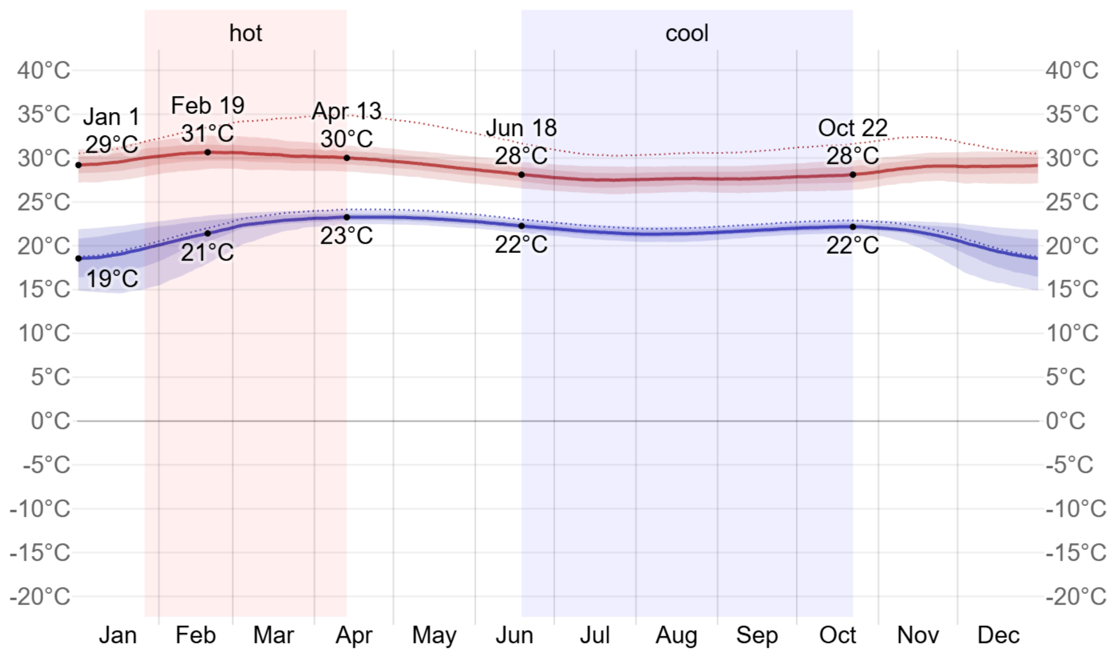
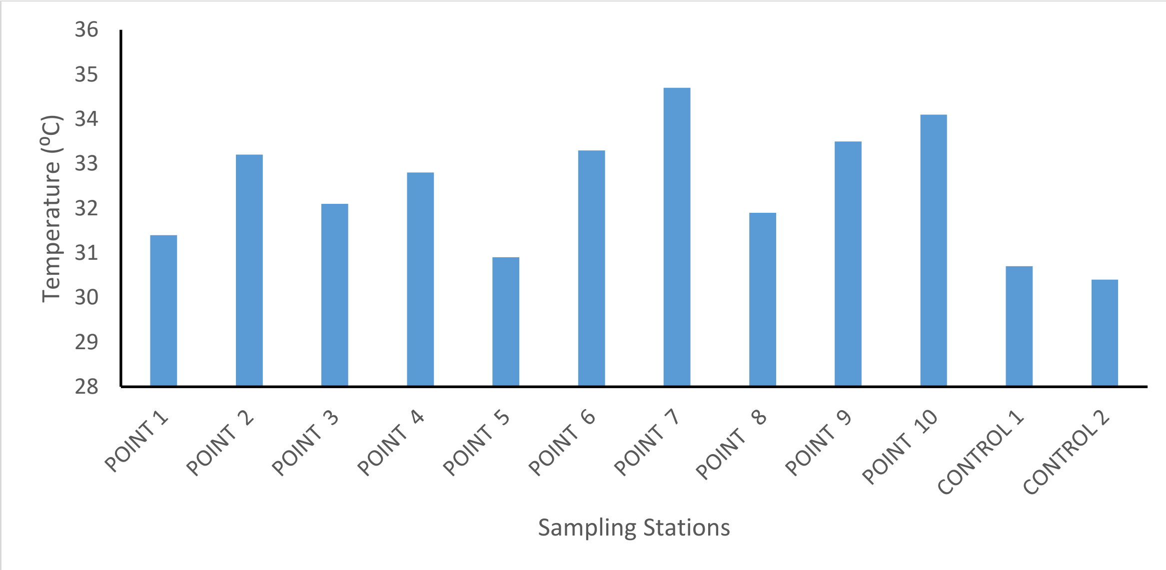



**Figure 4.6: Annual Average temperature within the Proposed Study Area**

**Source: Weather Spark, 2026**

The ambient temperature measurements across the proposed 500 MT LPG blending project site ranged from 30.9 to 34.7°C, with a mean of 32.79 ± 1.21°C, while the control locations recorded an average temperature of 30.55°C. The highest temperature (34.7°C) was recorded at Point 7, whereas the lowest (30.9°C) occurred at Point 5 (**Table 4.3 and Figure 4.7**)

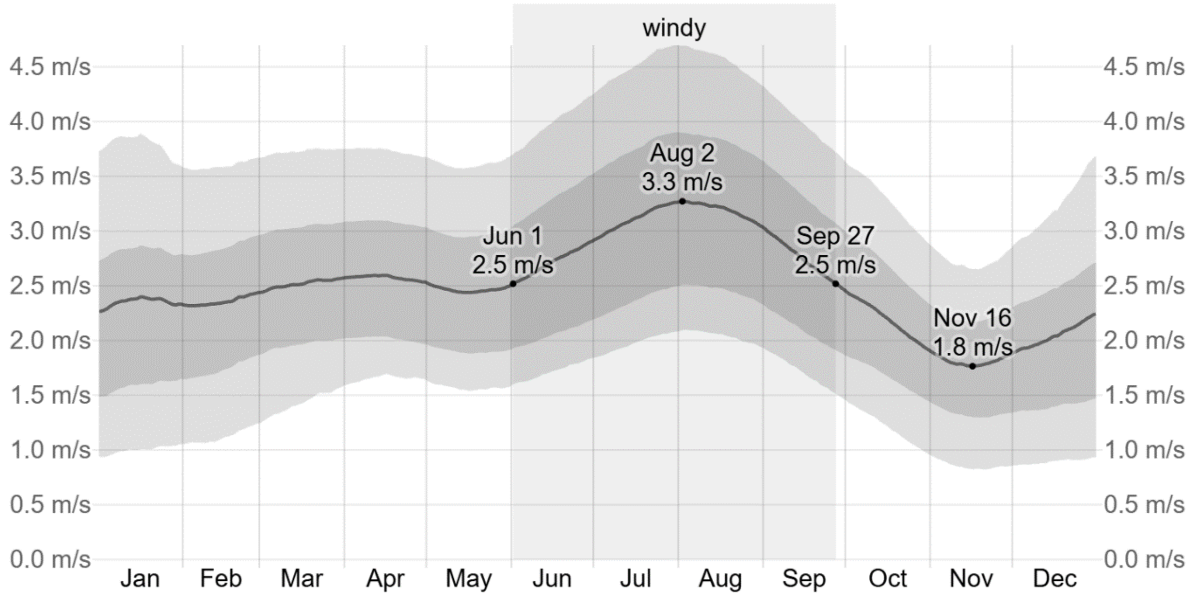



**Figures 4.7: Temperature (ºC) Mean Data at Proposed Rainoil 500MT LPG Blending Plant**

### 4.3.1.3 Wind Speed

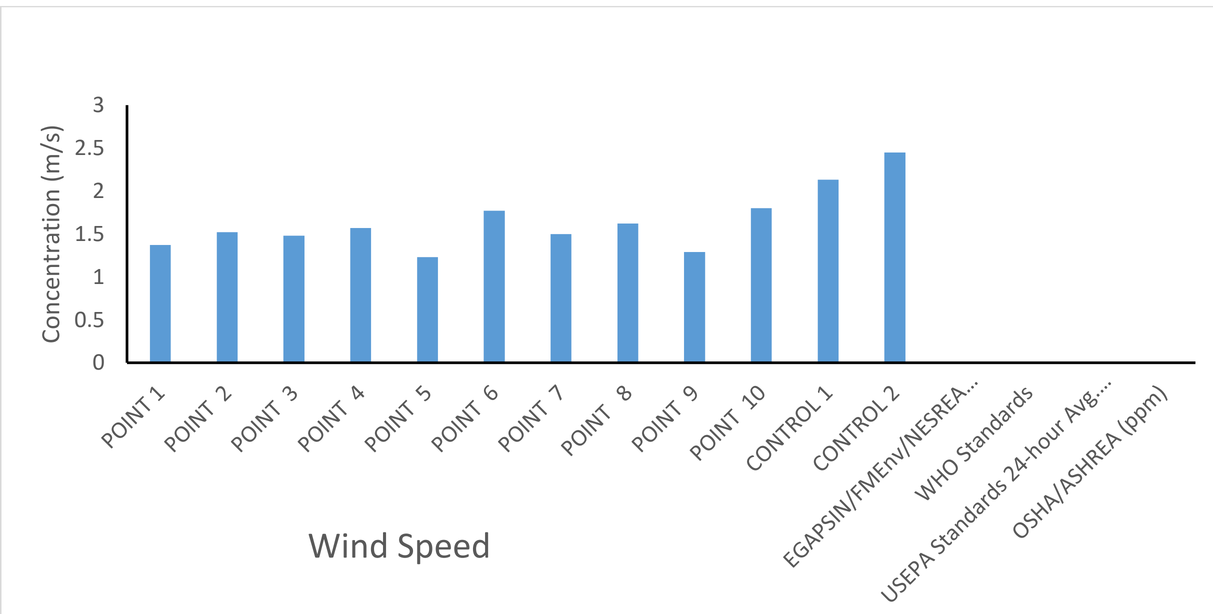
Wind speed as an important meteorological parameter in ambient air quality assessment because it governs the transport, dilution and dispersion of atmospheric pollutants. The rate at which pollutants emitted from construction equipment, vehicular traffic, storage facilities and process units are dispersed largely depends on prevailing wind conditions. Consequently, the wind speed data shall provide valuable information for predicting pollutant movement, assessing the extent of atmospheric impacts and designing appropriate environmental management measures for industrial facilities such as Liquefied Petroleum Gas (LPG) blending plants (**Figure 4.8**).

The measured wind speed across the monitoring locations ranged from 1.23 to 2.45 m/s, with an average value of 1.64 ± 0.35 m/s. The observed variation indicates relatively stable and moderate wind conditions across the study area. The lowest wind speed of 1.23 m/s was recorded at Point 5, while the highest value of 2.45 m/s was measured at Control Point 2, suggesting slight spatial variability that is typical of local terrain, vegetation cover and surface roughness (**Figure 4.9**).




**Figures 4.8: Annual wind speed (m/s) within the Proposed Study Area**

**Source:** Weather Spark, 2026




**Figures 4.9: Wind Speed (m/s) Mean Data at Proposed Rainoil 500MT LPG Blending Plant**

From an environmental perspective, the recorded wind speeds are considered adequate to facilitate the dispersion and dilution of atmospheric pollutants under normal operating conditions. Moderate wind velocities reduce the likelihood of pollutant accumulation near emission sources by promoting horizontal transport and atmospheric mixing. Consequently, gaseous emissions such as carbon monoxide (CO), nitrogen oxides ($NO_x$), sulphur dioxide ($SO_2$), volatile organic compounds (VOCs) and fugitive LPG vapours released during project operations are expected to disperse efficiently rather than accumulate at ground level.

The prevailing wind regime also has important implications for the proposed 500MT LPG project planning and environmental risk management. During the construction phase, moderate winds will assist in dispersing exhaust emissions from heavy-duty machinery and construction vehicles. During the operational phase, the prevailing wind conditions will facilitate the dilution of any accidental fugitive emissions arising from loading operations, pressure relief valves, pumps, compressors or storage vessels. However, although moderate wind speeds improve atmospheric dispersion, they may also increase the transport distance of airborne dust generated during site clearing, excavation and earthworks if appropriate dust suppression measures are not implemented. Therefore, regular water spraying, prompt rehabilitation of disturbed surfaces, speed control of construction vehicles and proper stockpile management should be incorporated into the Environmental and Social Management Plan (ESMP) to minimize off-site dust migration.

#### 4.3.1.4 Wind Direction

The wide-area hourly average wind vector (speed and direction) is being analysed at 10 metres above the ground. The wind is based on the location and it is also dependent on local topography and other factors, such as instantaneous wind speed and direction which may vary more widely than hourly averages and every 2kph. For six days, from January 4 to January 10, the wind is most frequently from the east, peaking at 32% on January 4. For eleven months, from January 10 to December 8, the wind comes primarily from the west, peaking at 80% on August 6. The wind is most often from the north for 3.9 weeks, from December 8 to January 4, with a peak percentage of 34% on January 1 (**Figure 4.10**).

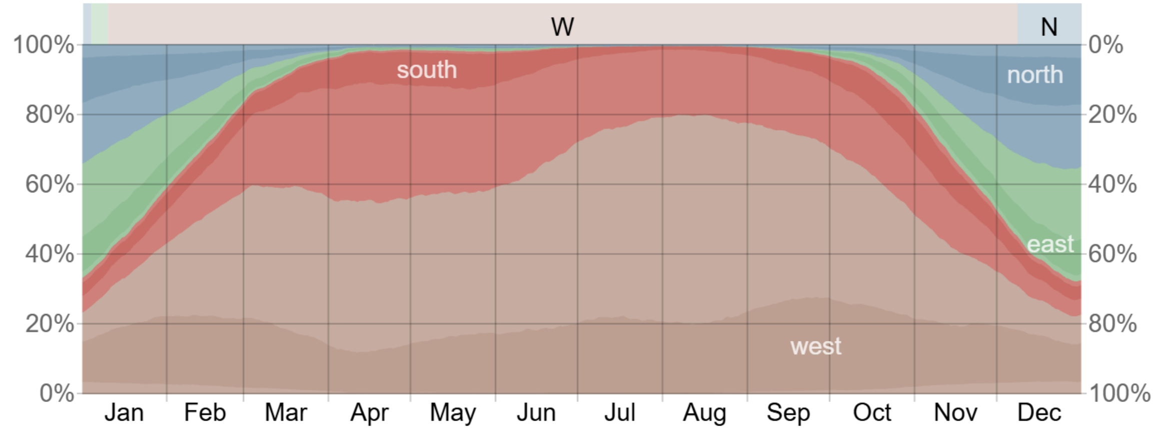
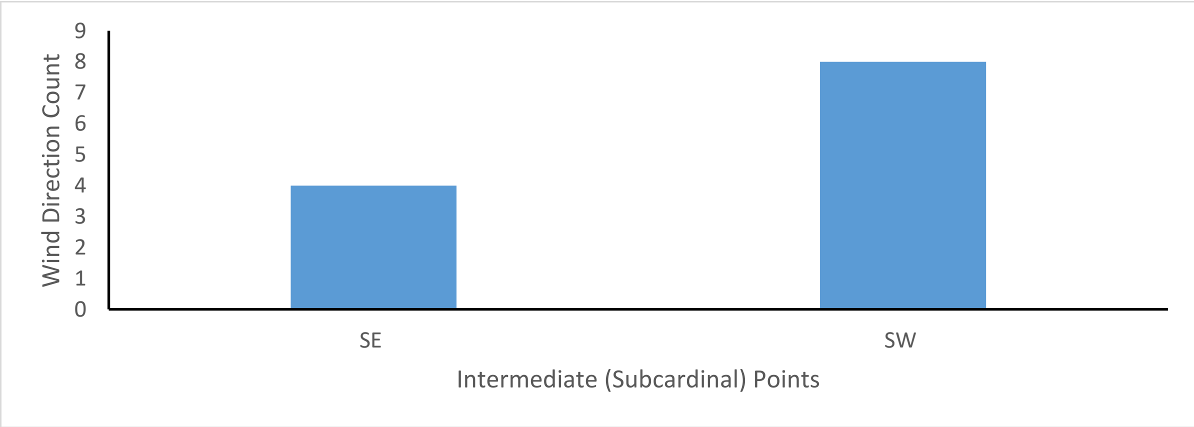



**Figure 4.10: Wind Direction at proposed Project Study Area**

**Source:** Weather Spark, 2026

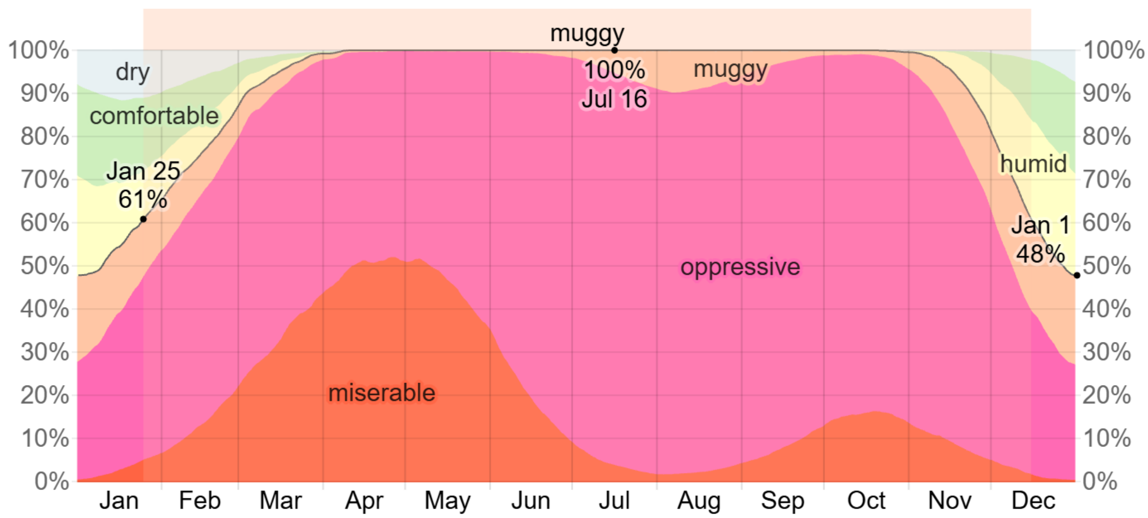
The predominant average hourly wind direction in Ibusa varies throughout the year. Wind direction is a key meteorological parameter governing the transport and dispersion of airborne pollutants, dust, odours, and accidental gaseous releases. Field measurements showed that the prevailing wind direction across the project area ranged between the Southeast (SE) and Southwest (SW), with Southwest winds predominating at most sampling locations. Both control stations also recorded Southwest (SW) winds, confirming that the observed airflow reflects the regional meteorological regime rather than localized site influences **(Table 4.5 and Figure 4.11)**.




**Figures 4.11: Wind Direction at Proposed Rainoil 500MT LPG Blending Plant**

#### 4.3.1.4 Relative Humidity

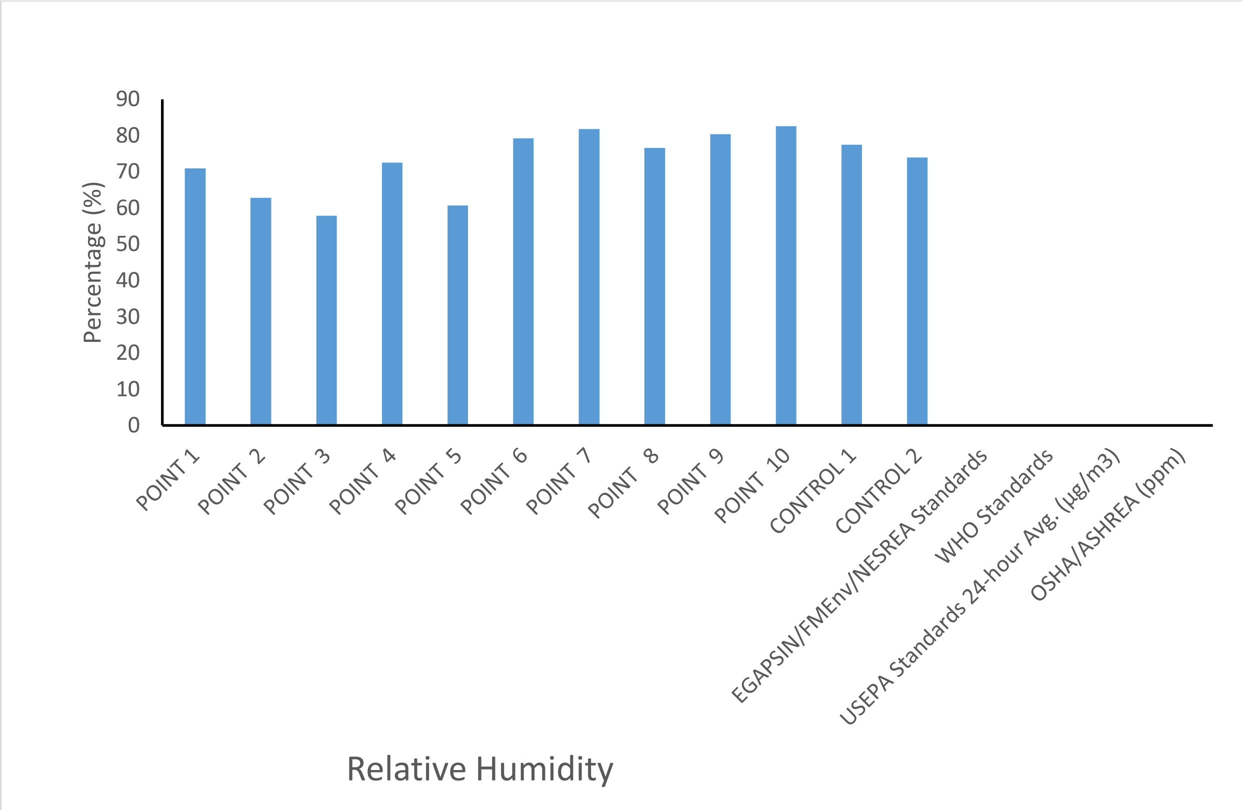
Relative humidity is another critical meteorological parameter that influences ambient air quality, atmospheric chemistry, pollutant deposition and human thermal comfort. It represents the amount of water vapour present in the atmosphere relative to the maximum quantity that the air can hold at a given temperature. Relative humidity directly affects the behaviour of airborne particulate matter, the atmospheric residence time of pollutants, and the rate of wet deposition processes. The regular average monthly relative humidity around the project area is slightly muggy/oppressive as also observed during the field data gathering (**Figure 4.12**).




**Figures 4.12: Relative Humidity (%) at the Proposed Project Area**

**Source: Weather Spark, 2026**

The measured relative humidity within the proposed project area ranged from 57.9% to 82.6%, with an average value of 73.07 ± 8.45% (**Figure 4.13**). These values are characteristic of the humid tropical climatic conditions of southern Nigeria and reflect the influence of maritime air masses, abundant vegetation and seasonal atmospheric moisture.




**Figures 4.13: Relative Humidity (%) at the Proposed 500MT LPG Blending Plant Project**

**Source: Field Data Gathering, June 2026**

The relatively high humidity recorded during the monitoring programme is environmentally beneficial because it promotes the natural removal of airborne particulates through moisture-induced agglomeration and gravitational settling. Under humid atmospheric conditions, fine dust particles absorb moisture, increase in size and settle more rapidly, thereby reducing ambient concentrations of suspended particulate matter. This mechanism contributes to the exceptionally low concentrations of $PM_{2.5}$ and $PM_{10}$ recorded during the baseline study and enhances the overall quality of the atmospheric environment.

High relative humidity also influences the atmospheric behaviour of gaseous pollutants. Moist air enhances certain chemical transformation processes and facilitates the scavenging of soluble gases from the atmosphere through wet deposition, thereby reducing their residence time. Consequently, the prevailing humidity conditions within the study area favour the natural attenuation of atmospheric contaminants and contribute to maintaining low background pollutant concentrations.

From the perspective of project implementation, the observed humidity regime indicates that the proposed LPG blending facility will operate within a climatic environment that naturally supports particulate suppression and atmospheric cleansing. Nevertheless, elevated humidity may also increase the susceptibility of metallic equipment, pipelines, storage vessels and structural components to corrosion if appropriate protective measures are not implemented. Therefore, corrosion-resistant materials, high-quality protective coatings, routine inspection programmes and preventive maintenance should form integral components of the project's asset integrity management system.

### 4.4 Surface water Study & Sediment Analysis

Surface water and sediment investigations are essential components of Environmental and Social Management Plan (ESMP) studies where project activities have the potential to directly or indirectly affect nearby aquatic ecosystems. Such investigations are undertaken to establish baseline physicochemical, biological and sediment quality conditions against which future project-related impacts can be assessed. They are particularly relevant where rivers, streams, lakes, wetlands, estuaries or other aquatic environments occur within the project area of influence and may receive stormwater runoff, wastewater discharges, accidental spills or sediment transport.

For the proposed Mini 500 MT Liquefied Petroleum Gas (LPG) Blending Project, a detailed site reconnaissance and environmental baseline survey confirmed that no river, stream, creek, lake, wetland or other perennial surface water body exists within a 5-kilometre radius of the proposed project site. Consequently, there was no hydrologically connected aquatic environment that could reasonably serve as a receptor of potential project-related contaminants under existing site conditions. In the absence of a surface water body, sediment sampling was equally unjustified because aquatic sediments occur only within rivers, streams, lakes, wetlands and similar depositional environments.

From a scientific standpoint, collecting surface water or sediment samples where no natural aquatic system exists would not generate meaningful baseline data and would not satisfy accepted environmental monitoring principles. Environmental baseline studies should focus on environmental receptors that are present and have a plausible pathway for project interaction. Conducting surface water and sediment analyses under these circumstances would therefore produce data with little environmental relevance and limited value for impact assessment or future compliance monitoring.

Hydrologically, the project area is not directly connected to any perennial surface drainage system capable of receiving routine operational discharges from the proposed facility. Any rainfall falling within the project site is expected to infiltrate the soil profile, undergo temporary surface ponding, or be conveyed through engineered drainage infrastructure rather than discharge into a natural watercourse. As a result, groundwater represents the principal water resource and the most environmentally relevant receptor for assessing potential impacts associated with the proposed development. Accordingly, the ESMP appropriately emphasized groundwater quality investigations, soil quality assessment and ambient air quality monitoring, which are more representative of the environmental setting of the project area.

Furthermore, the proposed LPG blending facility is designed as a downstream petroleum installation operating within a closed handling and storage system. LPG is stored in pressurized vessels and transferred through enclosed pipelines and controlled loading systems, minimizing the likelihood of routine liquid effluent generation. The facility design incorporates engineered stormwater drainage, spill prevention and control measures, leak detection systems, secondary containment around storage facilities, and emergency response procedures to prevent accidental releases to the environment. These engineering controls further reduce the potential for off-site migration of contaminants toward distant aquatic ecosystems.

Although no surface water body currently exists within the project influence area, environmental protection measures should nevertheless be implemented throughout the construction and operational phases to prevent uncontrolled runoff, erosion and accidental hydrocarbon releases. Proper stormwater management, good housekeeping practices, spill prevention and response procedures, routine inspection of drainage systems, and effective waste management will ensure that any future surface drainage generated within the project site does not adversely affect downstream environments should new drainage pathways or water bodies develop over time. Effective management of runoff and waste is widely recognized as an important measure for preventing contamination of receiving water bodies where they exist.

### 4.5 Soil Studies

Soil is an unconsolidated mineral matter on the immediate surface of the earth that serves as a natural medium for the growth of land plants and has been subjected to and influenced by genetic and environmental factors of parent material, climate (including moisture and temperature effects), macro- and microorganisms, and topography, all acting over a period of time and producing a product -soil- that differs from the material from which it was derived in many physical, chemical, biological, and morphological properties and characteristics. Soil is a complex system, consisting of three phases: soil gases; soil water; and organic/inorganic solids. For a soil impacted by wastes, a fourth phase, non-aqueous phase liquids (NAPLs), may also be present.

Soil quality assessment is a fundamental component of an Environmental and Social Management Plan (ESMP) because it establishes the baseline environmental condition of the proposed project site prior to development. Baseline soil characterization provides essential information on the physical, chemical, and biological properties of the soil, enabling the prediction of potential project-related impacts and facilitating future environmental monitoring. For the proposed 500 MT Liquefied Petroleum Gas (LPG) Blending Plant at Ibusa, Delta State, soil investigations were undertaken to evaluate the suitability of the site for construction and operation, while also determining whether historical contamination exists.

The investigation focused on the analysis of topsoil (0–15 cm) and bottom soil (15–30 cm) because these layers represent distinct environmental compartments. Topsoil is the biologically active horizon that supports vegetation growth, microbial activities, nutrient cycling, and surface infiltration processes. It is also the first soil layer likely to be affected by anthropogenic activities. Conversely, bottom soil reflects the subsurface environment where contaminants may migrate through infiltration and where engineering foundations interact directly with the soil matrix.

### 4.5.1 Physico-Chemical Characteristics of Soil Samples in the Proposed Project Area

Summary of results obtained for the physico-chemical characteristics of soil samples of the study area in top (0-15cm) and bottom (15-30cm) layers for dry season are presented in **Tables 4.3** while the details are presented in **Appendix D**.

**Table 4.3: Summary of Results of Soil Chemistry (Top and Bottom) from the Proposed Rainoil 500MT LPG Blending Plant Project site at Ibusa**

| PARAMETERS | | SURFACE SOIL (0-15CM) | | | SUBSURFACE SOIL (15-30CM) | | |
|---|---|---|---|---|---|---|---|
| | | AVERAGE± SD | RANGE | CONTROL AVERAGE± SD | AVERAGE± SD | RANGE | CONTROL AVERAGE± SD |
| pH | | 4.85±0.686 | 4.21-6.27 | 4.66±0.092 | 4.68±0.529 | 4.10-5.44 | 4.52±0.198 |
| EC (µS/cm) | | 0.04±0.022 | 0.016-0.083 | 0.037±0.022 | 0.031±0.022 | 0.012-0.079 | 0.03±0.013 |
| Grain size | Sand (%) | 56.83±1.961 | 51.8-58.6 | 53.1±0.849 | 57.51±1.574 | 54.8-59.2 | 52.95±1.626 |
| | Silt (%) | 17.57±1.643 | 13.4-19.6 | 13.4±0.283 | 16.16±2.492 | 12.3-18.6 | 13.1±0.849 |
| | Clay (%) | 25.6±3.306 | 23.4-34.8 | 33.5±1.131 | 26.83±3.661 | 23.3-33.6 | 33.95±0.778 |
| Bulk Density (g/cm) | | 1.39±0.121 | 1.21-1.61 | 1.33±0.134 | 1.35±0.164 | 1.16-1.62 | 1.17±0.021 |
| Textural Class | | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam |
| Porosity (%) | | 59.7±6.29 | 48-68 | 63.5±6.364 | 59.5±4.972 | 50-67 | 55±2.828 |
| Permeability (cm/s) | | 0.12±0.083 | 0.02-0.28 | 0.07±0.035 | 0.14±0.113 | 0.02-0.32 | 0.1±0.028 |
| T.N (%) | | 0.63±0.445 | 0.07-1.67 | 1.44±0.163 | 0.64±0.408 | 0.11-1.58 | 1.34±0.127 |
| TOC (%) | | 0.92±0.324 | 0.39-1.31 | 0.73±0.226 | 0.82±0.35 | 0.28-1.24 | 0.55±0.184 |
| $PO_4$ (mg/kg) | | 1.47±0.225 | 1.13-1.81 | 1.23±0.813 | 1.55±0.257 | 1.16-1.96 | 0.64±0.156 |
| $SO_4$ (mg/kg) | | 0.05±0.043 | 0-0.12 | 0.06±0.007 | 0.06±0.054 | 0-0.16 | 0.11±0.035 |
| $NO_3$ (mg/kg)g | | 1.88±0.532 | 1.13-2.74 | 1.16±0.156 | 1.87±0.517 | 1.05-2.51 | 0.99±0.184 |
| NO2 (mg/kg) | | 3.51±1.036 | 2.28-5.72 | 2.82±1.52 | 3.03±0.617 | 2.15-4.18 | 2.56±1.478 |
| THC (mg/kg) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| TPH (mg/kg)g | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

| PARAMETERS | SURFACE SOIL (0-15CM) | | | SUBSURFACE SOIL (15-30CM) | | |
|---|---|---|---|---|---|---|
| | AVERAGE± SD | RANGE | CONTROL AVERAGE± SD | AVERAGE± SD | RANGE | CONTROL AVERAGE± SD |
| Zn (mg/kg) | 25±6.861 | 11.216-32.876 | 10.16±1.117 | 21.5±6.927 | 8.273-29.109 | 6.36±1.792 |
| BTEX (mg/kg) | <0.001 | <0.001 | <0.001 | <0.001 | 0-0 | <0.001 |
| Fe (mg/kg) | 552.5±114.991 | 393.215-781.543 | 333.37±51.158 | 473.05±113.789 | 277.682-659.376 | 302.28±50.309 |
| Cd (mg/kg) | 0.18±0.059 | 0.113-0.261 | 0.19±0.017 | 0.17±0.055 | 0.105-0.252 | 0.17±0.016 |
| Cr (mg/kg) | 2.54±1.023 | 1.078-4.188 | 0.63±0.14 | 1.93±0.778 | 0.856-3.256 | 0.39±0.187 |
| Ni (mg/kg) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| V (mg/kg) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Pb (mg/kg) | 0.17±0.049 | 0.115-0.283 | 0.06±0.017 | 0.16±0.045 | 0.109-0.254 | 0.05±0.011 |
| Ba (mg/kg) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Hg (mg/kg) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

Source: Field Data from Proposed ESMP Rainoil 500MT LPG Blending Plant Project Site, 2026

### 4.5.2 The physico-chemical parameters of analysis:

***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.

During the ESMP study, the soil analysis reveals pH values of the surface (0 – 15cm) and subsurface (15 - 30cm) soils of the study area showed that the soils were acidic (with values that range from 4.21-6.27 for topsoils (surface soils) with an averaged value of 4.85 ± 0.69 while the bottom soils (sub-surface soils) values ranged from 4.10-5.44 with an average value of 4.68 ± 0.53. The corresponding control values had an average mean value of 4.66 ± 0.09 and 4.52 ± 0.20 for topsoil and bottom soil, respectively. These results indicate that both soil horizons are strongly acidic. The slightly higher pH observed in the topsoil relative to the bottom soil is likely consistent with the influence of surface organic matter decomposition, litter accumulation and microbial activity. This is consistent with recorded data on soils of the study area and of the

Niger Delta region (NDES, 1997; Anderson, 1967). Generally, the soils of the Niger-Delta area vary from the order Oxisols to Ultisols. Ultisols are strongly acidic, extensively weathered soils of tropical and subtropical climates (Soil Survey Staff, 1975, Odu *et al*, 1985).

***Electrical Conductivity (EC):*** Electrical conductivity is a measure of the electric current carrying ability of an aqueous solution. It measures the concentration of soluble ions within soil pore water and provides an indication of salinity. The surface soil EC concentration had an averaged average value of 0.04 ± 0.022 µS/cm, with values ranging from 0.016–0.083 µS/cm, while the subsurface soil had an averaged value of 0.031 ± 0.022 µS/cm, ranging from 0.012–0.079 µS/cm. Control values were 0.037 ± 0.022 µS/cm (topsoil 0-15cm) and 0.03 ± 0.013 µS/cm (bottom soil 15-30cm), respectively.

The extremely low EC values indicate that the soils possess very low soluble salt concentrations, suggesting that salinity is not a limiting factor for vegetation growth or engineering performance. The negligible differences between project and control samples further confirm that no significant accumulation of dissolved salts has occurred. Low electrical conductivity is typical of well-drained tropical sandy soils where continuous rainfall promotes leaching of soluble ions. From an ESMP perspective, the low EC values indicate favourable baseline soil conditions with minimal likelihood of salinity-induced degradation during project development.

**Particle Size Distribution (Sand, Silt and Clay):** Grain size distribution is one of the most important physical properties evaluated during baseline soil investigations because it controls soil hydraulic conductivity, infiltration capacity, water retention, aeration, erodibility, engineering behaviour and contaminant transport. The relative proportions of sand, silt and clay determine the soil textural class and provide critical information for assessing the suitability of a site for industrial infrastructure, foundation design and environmental management. Particle-size distribution is commonly determined through sieve analysis and sedimentation techniques and forms the basis for soil texture classification in engineering and environmental studies. The soil laboratory results indicate that both the topsoil (0–15 cm) and bottom soil (15–30 cm) are dominated by sand, with comparatively lower proportions of silt and clay, resulting in a sandy loam textural classification. The relatively small standard deviation values recorded for all particle-size fractions indicate minimal spatial variability across the study area and suggest a fairly homogeneous parent material.

**Sand:** The sand content within the proposed project area had average sand content of 56.83 ± 1.96% in the sureface soil and 57.51 ± 1.57% in the subsurface soil. The soil had control values of 53.10 ± 0.85% and 52.95 ± 1.63% for surface and subsurface soils respectively (**Table 4.3**). The slightly higher sand content within the project area relative to the control site indicates a coarse-textured soil with excellent permeability, rapid infiltration, and efficient drainage. The narrow standard deviations demonstrate that sand distribution is relatively uniform throughout the site. Such soils are less susceptible to prolonged waterlogging and provide favourable engineering conditions for excavation, compaction, and foundation construction. However, the high sand fraction also implies relatively low moisture- and nutrient-retention capacity and a greater potential for downward migration of contaminants in the event of accidental hydrocarbon spills.

**Silt**

The observed silt content of the proposed site had an average value of 17.57 ± 1.64% in the surface soil and 16.16 ± 2.49% in the subsurface soil, while the corresponding control values were 13.40 ± 0.28% and 13.10 ± 0.85% for surface and subsurface soils respectively (**Table 4.3**). The moderate silt content complements the sandy matrix by improving moisture retention, nutrient storage, and soil cohesion without significantly reducing permeability. The slightly greater variability in the bottom soil, reflected by the higher standard deviation, is consistent with natural subsurface heterogeneity and depositional processes.

**Clay**

Clay content had an average value of 25.60 ± 3.31% in the surface soil and 26.83 ± 3.66% within the subsurface soil, compared with control values of 33.50 ± 1.13% and 33.95 ± 0.78% for surface and subsurface soils respectively. The slightly higher clay content in the bottom soil reflects natural illuviation, whereby fine particles migrate downward during prolonged weathering and soil profile development. Although the project site contains less clay than the control location, the measured concentrations remain sufficient to improve aggregate stability, cation exchange capacity and moisture retention while remaining low enough to minimize excessive shrink–swell behaviour. Consequently, the soil is unlikely to experience significant differential settlement or volume change that could compromise foundations or underground utilities.

**Soil Textural Class:** Based on the proportions of sand, silt and clay, both topsoil and bottom soil were classified as Sandy Loam (**Table 4.3**). Sandy loam soils are considered highly suitable for industrial developments because they combine: good drainage, moderate moisture retention, adequate aeration, ease of excavation, low susceptibility to waterlogging, and good bearing characteristics. These properties make the soil favourable for foundation construction, underground utilities and stormwater infiltration systems associated with the proposed LPG blending facility.

**Bulk Density:** The average bulk density measured within the proposed project area was 1.39 ± 0.12 g/cm³ for surface soil with values ranging from 1.21 to 1.61 g/cm³ while that of subsurface soil ranged from 1.16 to 1.62 g/cm³ with an average value of 1.35 ± 0.16 g/cm³. The control values for surface and subsurface soil were 1.33 ± 0.13 g/cm³ and 1.17 ± 0.02 g/cm³ respectively (**Table 4.3**). These values fall within the normal range for sandy loam soils and indicate moderate compaction.

**Porosity**

The average value for the proposed area soil porosity was 59.7 ± 6.29% (ranging from 48-68%) for surface soil and 59.5 ± 4.97% (ranging from 50-67%) for subsurface soil. Their corresponding control values were 63.5 ± 6.36% and 55.0 ± 2.83% for surface and subsurface soil respectively (**Table 4.3**).

These high porosity values indicate that the soils contain abundant interconnected pore spaces, facilitating water infiltration, gas exchange, root development, microbial activity.

**Permeability:** Permeability concentration for surface soil had an average value of 0.12 ± 0.083 cm/s with values ranging from 0.02 to 0.28 cm/s while that of subsurface soil ranged from 0.02 to 0.32cm/s with an average value of 0.14 ± 0.113 cm/s. Control values were 0.07 ± 0.035 cm/s and 0.10 ± 0.028 cm/s for surface and subsurface soils respectively (**Table 4.3**). The relatively high permeability reflects the sandy loam nature of the soil and indicates rapid movement of water through the soil profile.

### 4.5.2 Nutrients:

### 4.3.8 Total Nitrogen (TN)

The laboratory analysis showed that the surface soil (0–15 cm) contained a mean TN concentration of 0.63 ± 0.45%, with values ranging from 0.07 to 1.67%, while the subsurface soil (15–30 cm) recorded 0.64 ± 0.41%, ranging from 0.11 to 1.58%. The corresponding control values were 1.44 ± 0.16% and 1.34 ± 0.13% for surface and subsurface soils respectively (**Table 4.3**).

### 4.3.9 Total Organic Carbon (TOC)

Total Organic Carbon (TOC) represents the quantity of carbon contained in soil organic matter and is widely regarded as one of the best indicators of soil quality. Organic carbon influences nutrient availability, microbial activity, aggregation, moisture retention and resistance to erosion. It is also a major determinant of long-term soil productivity and ecosystem resilience.

The laboratory results revealed a surface soil TOC concentration of 0.92 ± 0.32%, with values ranging from 0.39 to 1.31%, whereas the subsurface soil recorded a mean concentration of 0.82 ± 0.35%, ranging from 0.28 to 1.24%. Corresponding control values were 0.73 ± 0.23% and 0.55 ± 0.18% for surface and subsurface soils respectively (**Table 4.3**). The slightly higher TOC content in the topsoil reflects the accumulation of decomposing plant litter, roots and microbial biomass near the soil surface. Such vertical distribution is characteristic of natural soils where organic inputs are concentrated within the upper horizon.

### 4.3.10 Phosphate ($PO_4^{3-}$)

The surface soil phosphate concentration had an average value of 1.47 ± 0.23 mg/kg, while the subsurface soil had an average value of 1.55 ± 0.26 mg/kg. Control values were 1.23 ± 0.81 mg/kg and 0.64 ± 0.16 mg/kg for surface and subsurface soils respectively (**Table 4.3**).

#### 4.3.11 Sulphate ($SO_4^{2-}$)

Sulphur is another essential plant nutrient involved in protein synthesis, enzyme activation and chlorophyll formation. Sulphate represents the principal plant-available form of sulphur within soils. The measured sulphate concentrations had an average value of 0.05 ± 0.04 mg/kg (<0.01-0.12 mg/kg) in surface soil and 0.06 ± 0.05 mg/kg (<0.01-0.16mg/kg) in subsurface soil, compared with control values of 0.06 ± 0.01 mg/kg and 0.11 ± 0.04 mg/kg for surface and subsurface soils respectively (**Table 4.3**). These concentrations are very low but are typical of highly weathered tropical soils where sulphate is readily leached by rainfall.

#### 4.3.12 Nitrate ($NO_3^-$)

Nitrate represents the most mobile and readily available form of nitrogen for plant uptake. However, because of its high solubility, nitrate can easily migrate through permeable soils and contaminate groundwater if present in excessive concentrations. The laboratory analysis showed that surface soil nitrate averaged 1.88 ± 0.53 mg/kg, while subsurface soil averaged 1.87 ± 0.52 mg/kg. Control values were 1.16 ± 0.16 mg/kg and 0.99 ± 0.18 mg/kg for surface and subsurface soils respectively (**Table 4.3**).

#### 4.3.13 Nitrite ($NO_2^-$)

Nitrite is an intermediate product in the biological conversion of ammonia to nitrate during nitrification and is generally present in soils at lower concentrations than nitrate because it is rapidly oxidized by soil microorganisms. The surface soil nitrite concentration averaged 3.51 ± 1.04 mg/kg, with values ranging from 2.28 to 5.72 mg/kg, while the bottom soil had an average value of 3.03 ± 0.62 mg/kg, ranging from 2.15 to 4.18 mg/kg. The corresponding control values were 2.82 ± 1.52 mg/kg and 2.56 ± 1.48 mg/kg for surface and subsurface soils, respectively (**Table 4.3**).

### 4.5.3 Petroleum Hydrocarbon Indicators

#### Total Hydrocarbon Content (THC)

The Total Hydrocarbon Content (THC) is an important environmental indicator used to evaluate the presence of hydrocarbon residues resulting from crude oil, petroleum products or related industrial activities. THC serves as an early indicator of petroleum contamination and provides valuable baseline information for monitoring future environmental changes associated with project implementation.

The laboratory analysis showed that THC concentrations in both the topsoil (0–15 cm) and bottom soil (15–30 cm) were below the analytical detection limit (<0.001 mg/kg) (**Table 4.3**). Similarly, the control samples also recorded concentrations below the equipment detection level of <0.001mg/kg.

### 4.3.15 Total Petroleum Hydrocarbon (TPH)

Total Petroleum Hydrocarbon (TPH) is widely recognized as one of the principal indicators of petroleum contamination in soils. It encompasses a broad spectrum of petroleum-derived compounds originating from crude oil, diesel, gasoline, lubricating oils and other refined petroleum products. TPH analysis is therefore routinely included in environmental baseline investigations for petroleum-related developments.

The laboratory analysis revealed that TPH concentrations in both topsoil and bottom soil were below the analytical detection limit (<0.001 mg/kg), with corresponding control samples also recording values below equipment detection level (**Table 4.3**).

### 4.3.16 Benzene, Toluene, Ethylbenzene and Xylene (BTEX)

BTEX compounds represent the most volatile and mobile components of petroleum products and are regarded as priority environmental pollutants because of their toxicity and high mobility in soils and groundwater. Their determination is therefore essential in baseline investigations for petroleum handling facilities.

The analytical results showed that BTEX concentrations in both topsoil and bottom soil were below the analytical detection limit (<0.001 mg/kg), while the control samples also recorded non-detectable concentrations (**Table 4.3**).

### 4.5.4 Heavy Metals

Heavy metals constitute one of the most important components of baseline soil investigations because of their persistence, toxicity, non-biodegradable nature and potential for bioaccumulation within terrestrial ecosystems. Unlike organic pollutants, heavy metals remain in soils for extended periods and may adversely affect vegetation, microorganisms, groundwater quality and ultimately human health if present above permissible concentrations. Consequently, the determination of heavy metal concentrations provides a reliable assessment of the existing environmental condition of the proposed project site prior to development.

The laboratory investigation determined concentrations of iron (Fe), zinc (Zn), cadmium (Cd), chromium (Cr), nickel (Ni), vanadium (V), lead (Pb), barium (Ba) and mercury (Hg) in both the surface soil (0–15 cm) and subsurface soil (15–30 cm). The results provide an important environmental baseline for future monitoring throughout the construction, operation and decommissioning phases of the proposed 500 MT LPG Blending Plant.

*Iron (Fe):* Iron is one of the most abundant naturally occurring elements in tropical soils and is an essential micronutrient required for chlorophyll synthesis, respiration and numerous enzymatic reactions. Although elevated iron concentrations are frequently encountered in highly weathered tropical soils, iron rarely constitutes an environmental contaminant because its occurrence is predominantly controlled by natural geological processes.

The laboratory results indicated mean iron concentrations of 552.50 ± 114.99 mg/kg (393.22-781.54 mg/kg) in the topsoil and 473.05 ± 113.79 mg/kg (277.68-659.38) in the bottom soil. Corresponding control values were 333.37 ± 51.16 mg/kg and 302.28 ± 50.31 mg/kg surface and subsurface soils respectively (**Table 4.3**).

*Zinc (Zn):* Zinc is an essential trace element required for enzyme activation, protein synthesis and normal plant metabolism. However, excessive zinc concentrations may impair soil microbial activity and plant growth. The average zinc concentration within the proposed project area was 25.00 ± 6.86 mg/kg in the surface soil and 21.50 ± 6.93 mg/kg in the subsurface soil, while the corresponding control values were 10.16 ± 1.12 mg/kg and 6.36 ± 1.79 mg/kg for surface and subsurface soils respectively (**Table 4.3**).

*Cadmium (Cd):* Cadmium is regarded as one of the most toxic heavy metals because of its high mobility and potential for bioaccumulation. Consequently, even relatively low concentrations warrant careful evaluation. The averagea Cadmium concentrations was 0.18 ± 0.06 mg/kg in the surface soil and 0.17 ± 0.06 mg/kg in the subsurface soil, while their control samples recorded 0.19 ± 0.02 mg/kg and 0.17 ± 0.02 mg/kg for surface and subsurface soils respectively (**Table 4.3**).

*Chromium (Cr):* Chromium occurs naturally within soils as a constituent of parent geological materials. However, elevated chromium concentrations may arise from industrial activities, waste disposal or petroleum-related operations. The study recorded average chromium concentrations of 2.54 ± 1.02 mg/kg in the surface soil and 1.93 ± 0.78 mg/kg in the subsurface soil. Control values were 0.63 ± 0.14 mg/kg and 0.39 ± 0.19 mg/kg surface and subsurface soils respectively (**Table 4.3**).

*Nickel (Ni):* Nickel concentrations in both topsoil and bottom soil were below the analytical detection limit (<0.001 mg/kg), with identical results recorded for the control samples (**Table 4.3**).

*Vanadium (V):* Vanadium concentrations were also below the analytical detection limit (<0.001 mg/kg) in all project and control samples (**Table 4.3**).

*Lead (Pb):* Lead is a persistent toxic metal capable of affecting soil microorganisms, plants and human health if present in elevated concentrations. The average lead concentration was 0.17 ± 0.05 mg/kg in the surface soil and 0.16 ± 0.05 mg/kg in the subsurface soil, compared with 0.06 ± 0.02 mg/kg and 0.05 ± 0.01 mg/kg for surface and subsurface soils in the control samples (**Table 4.3**).

*Barium (Ba):* Barium concentrations were below the analytical detection limit (<0.001 mg/kg) in both project and control soils (**Table 4.3**).

*Mercury (Hg):* Mercury is among the most environmentally hazardous heavy metals because of its toxicity and ability to undergo biomagnification. The laboratory analysis indicated that mercury concentrations were below the analytical detection limit (<0.001 mg/kg) in all project and control samples (**Table 4.3**).

### 4.5.5 Microbiologically Characteristics of Soil Samples in the Proposed Project Area

The microbial status of the soil samples in the study as expressed in their range of values are presented in **Table 4.4** while the details are presented in **Appendix D**.

**Table 4.4: Summary of Soil Microbiological Characteristics in the Proposed Project Area**

| PARAMETERS | SURFACE SOIL (0-15CM) | | | SUBSURFACE SOIL (15-30CM) | | |
|---|---|---|---|---|---|---|
| | AVERAGE± SD | RANGE | CONTROL AVERAGE± SD | AVERAGE± SD | RANGE | CONTROL AVERAGE± SD |
| THB (cfu/g×$10^7$) | 0.32±0.287 | 0-0.66 | 0.19±0.269 | 0.41±0.228 | 0-0.63 | 0.19±0.269 |
| THF (cfu/g×$10^3$) | 1.05±0.155 | 0.81-1.27 | 1.02±0.028 | 1.14±0.111 | 1.01-1.36 | 0.97±0.099 |
| HUB (cfu/g×$10^5$) | 0.09±0.12 | 0-0.28 | ND | 0.23±0.036 | 0.17-0.27 | ND |
| HUF cfu/g×102 | 2.34±0.381 | 1.77-2.96 | 2.22±0.057 | 2.47±0.213 | 2.2-2.83 | 2.11±0.219 |

Source: Field Data from Proposed ESMP Rainoil 500MT LPG Blending Plant Project Site, 2026

### 4.3.17 Total Heterotrophic Bacteria (THB)

Total Heterotrophic Bacteria (THB) represent the general bacterial population responsible for decomposition of organic matter, nutrient mineralization and maintenance of ecological processes within soils. The study recorded mean THB populations of 0.32 ± 0.29 × $10^7$ cfu/g in the surface soil and 0.41 ± 0.23 × $10^7$ cfu/g in the subsurface soil, compared with 0.19 ± 0.27 × $10^7$ cfu/g in both control horizons (**Table 4.4**).

The relatively abundant bacterial populations demonstrate that the soils support active microbial communities capable of sustaining normal decomposition and nutrient cycling. The slightly higher bacterial density within the bottom soil may reflect favourable moisture conditions and protection from surface environmental fluctuations.

### 4.3.19 Hydrocarbon Utilizing Bacteria (HUB)

Hydrocarbon Utilizing Bacteria (HUB) constitute specialized microorganisms capable of degrading petroleum hydrocarbons and are commonly used as biological indicators of hydrocarbon exposure. The study recorded HUB populations of 0.09 ± 0.12 × $10^5$ cfu/g in the surface soil and 0.23 ± 0.04 × $10^5$ cfu/g in the subsurface soil, whereas the control samples recorded Not Detected (ND) in both surface and subsurface soils (**Table 4.4**).

### 4.3.18 Total Heterotrophic Fungi (THF)

Total Heterotrophic Fungi (THF) are important decomposers responsible for degrading complex organic materials, stabilizing soil aggregates and promoting nutrient recycling. The laboratory results showed THF populations of 1.05 ± 0.16 × $10^3$ cfu/g in the surface soil and 1.14 ± 0.11 × $10^3$ cfu/g in the subsurface soil. Control values were 1.02 ± 0.03 × $10^3$ cfu/g and 0.97 ± 0.10 × $10^3$ cfu/g for the surface and subsurface soils respectively (**Table 4.4**).

### 4.3.20 Hydrocarbon Utilizing Fungi (HUF)

Hydrocarbon Utilizing Fungi (HUF) are specialized fungi capable of metabolizing petroleum hydrocarbons and play important roles in the natural attenuation of contaminated soils. The average mean value of HUF populations was 2.34 ± 0.38 × $10^2$ cfu/g in the surface soil and 2.47 ± 0.21 × $10^2$ cfu/g in the subsurface soil, while control values were 2.22 ± 0.06 × $10^2$ cfu/g and 2.11 ± 0.22 × $10^2$ cfu/g for surface and subsurface soils respectively (**Table 4.4**). The similarity between project and control samples indicates that hydrocarbon-utilizing fungi occur naturally within the soil ecosystem. Their presence does not imply hydrocarbon pollution because corresponding chemical analyses confirmed that petroleum hydrocarbons were below detectable concentrations.

## 4.6 GEOLOGY AND HYDROGEOLOGY

### 4.6.1 Geology and Geomorphology

The Management of Rainoil Limited/Rainoil Gas Limited requested that a groundwater flow direction and recharge analyses be conducted in Ibusa, Community of Oshimili North Local Government Area, Delta State, Nigeria. The initiative was purposed to establish a baseline environmental database in view of the proposed 500MT LPG Blending Plant project. The possibility of accidental fuel spillage, wastewater discharges, chemical spills impact on groundwater, the extent of impact as well as groundwater vulnerability to impact which could be initiated by this facility cannot be undermined. However, local hill slopes, slight changes in land elevation, and discharge into neighboring drainage systems like the Atapo and Obosh Rivers also influence groundwater circulation. These investigations were conducted on the Wednesday, 26$^{th}$ to 27$^{th}$ June 2026 in accordance with standard scientific practices to ensure the objectives of the company were justified.

The scope covers the determination of the groundwater flow direction and estimated the groundwater recharge.

Ibusa, located in Oshimili North Local Government Area of Delta State, is situated on the Benin Formation of the Niger Delta Basin, which is of Oligocene to Recent age. The Benin Formation is composed predominantly of poorly consolidated to unconsolidated coarse- to medium-grained sands, gravelly sands, pebbly horizons and minor clay intercalations deposited in continental fluvial and upper deltaic environments. These highly permeable sandy deposits constitute the principal freshwater-bearing aquifer system across the area and overlie the underlying Agbada Formation, which in turn rests on the deeper marine Akata Formation, forming the three major lithostratigraphic units of the Niger Delta Basin.

The geomorphology of the Ibusa area is characterized by gently undulating to low-relief terrain dissected by seasonal drainage channels and broad interfluves, with elevations generally higher than the adjoining Niger floodplain. Surface runoff is controlled by the regional topographic gradient and ultimately drains eastward toward the River Niger through an interconnected network of ephemeral streams and drainage channels. The highly permeable sandy soils promote substantial rainfall infiltration and groundwater recharge, making the Benin Formation a prolific aquifer and the dominant hydrogeological unit underlying the proposed project area.

### 4.6.2 Hydrogeology

The main aquifer system in the Niger Delta region comprises of two stratigraphic units.  These are:

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

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

Recharge to this system is mainly from rainfall, while discharge sources include run-offs from the basin and abstraction through boreholes. **Table 4.5** below shows the aquifer prospectivity of the Niger Delta Basin.

**Table 4.5: Stratigraphic sequence of the Niger Delta Basin with aquifer prospectively (Source: Olobaniyi *et al*., 2006)**

| | Stratigraphic Units | Lithologic Description | Aquifer Prospect |
|---|---|---|---|
| QUAT ERNARY | ALLUVIUM | Gravely sands, sands, silt and clays | Good |
| | MEANDER BELT DEPOSIT | Gravely sands, sands with thin clay units. | Good |
| | WOODED BACK SWAMPS & FRESH-WATER SWAMPS DEPOSITS | Mainly silt and silty clays with clayey intercalations | Poor |
| | MANGROVE SWAMPS DEPOSIT | Fine sands to silt and silty clays and clays with organic matter | Poor (Saline water) |
| | SOMBREIRO-DELTAIC PLAIN SEDIMENTS | Coarse to fine grained sands, silts and clays | Medium |
| MIOCENE TO RECENT | BENIN FORMATION | Mainly coarse-medium grained sands, lenticular with clay and shaly lens | Prolific Aquifer |

### 4.6.2.1 BOREHOLE INFORMATION

Two (2) boreholes were drilled within the proposed site and a control outside the project site using percussion drilling method. Drill cores were sampled at intervals of 2m for lithologic analysis. These boreholes were cased using 4" PVC pipes, gravel packed and cemented. The dept to water levels of all the boreholes were obtained using an electronic dip meter. Some chemical parameters of the borehole water samples were measured insitu before they were dispatched for further laboratory analysis. GPS coordinates were recorded for all sample locations.

However, following the need to determine groundwater flow direction, borehole data were collected at three borehole points and presented as shown in **Table 4.6** below.

**Table 4.6: Borehole Information of Ibusa**

| Borehole No | **BH1** | **BH2** | **BH Control** |
|---|---|---|---|
| Water level (m) | 55.22 | 54.94 | 56.46 |
| Elevation (m) | 121.80 | 122.21 | 120.44 |
| Hydraulic Head (H) in meters | 70.10 | 70.28 | 71.70 |

Source: Field Data from Proposed ESMP Rainoil 500MT LPG Blending Plant Project Site, 2026

The flow direction was determined using the Two-Point-Problem. Two boreholes were drilled at two points in the site and their geographic positions were recorded using the hand held Global Positioning System (GPS). With aid of a water level indicator, the depth to water table ($D_{wl}$) at each borehole (BH) was recorded. The surface elevation and depth to water table were used in calculating the hydraulic head at the respective borehole points using the equation below.

$H=E - D_{wl}$

Where H = Hydraulic head

E = Surface Elevation

Dtw =Depth from top of borehole casing to water level

Hg = Height of casing above the ground

$D_{wl=}$ Depth to water table=Dtw-Hg

A direction perpendicular to the equi-potential line (line joining points of equal Hydraulic head) is known as the groundwater flow direction (**Figure 4.14**).

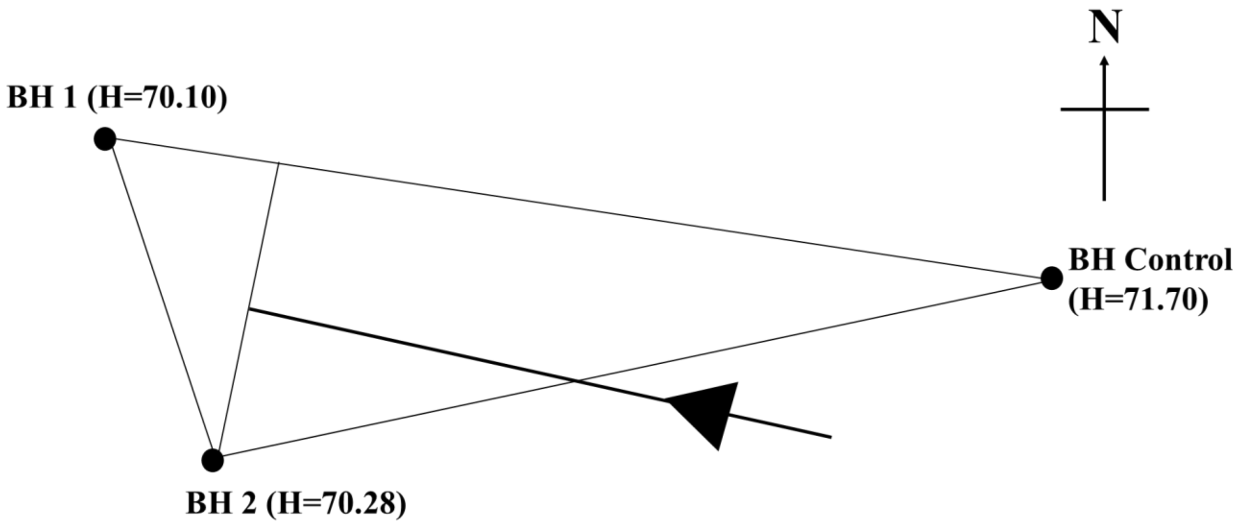



**Figure 4.14: Flow Net Diagram showing groundwater flow direction**

### 4.6.2.2 GROUNWATER FLOW DIRECTION ANALYSIS

The hydrogeological assessment of the Proposed 500MT LPG Blending Plant indicates that groundwater within the proposed project site flows in a south to south-southwest (S–SSW) direction, as indicated by the perpendicular line to the equipotential line. This reflects the regional hydraulic gradient and the natural topographic configuration of the area. This groundwater movement is controlled by subtle variations in land elevation, local hill slopes, and discharge toward nearby drainage systems such as the Atapo and Obosh Rivers.

For the proposed 500 MT Liquefied Petroleum Gas (LPG) Blending Project, the inferred south to south-southwest groundwater flow direction provides an important basis for environmental risk assessment and groundwater monitoring. In the unlikely event of subsurface contamination from ancillary materials such as lubricants, diesel, or firefighting chemicals, contaminants would be expected to migrate preferentially along the regional hydraulic gradient toward the south–southwest. Consequently, downgradient groundwater monitoring locations should be established in this direction to facilitate early detection of any contaminant migration and to ensure effective implementation of the ESMP. This understanding supports appropriate siting of monitoring boreholes, spill containment systems, and long-term groundwater protection measures.

#### 4.6.2.3 GROUNDWATER RECHARGE ANALYSIS

On the basis of the above equation, the estimated groundwater recharge of the area is 1686mm which is about 61% of the annual rainfall of the area. This implies there is high rate of infiltration than surface run-off in Ibusa which means groundwater contamination vulnerability in the area is high.

#### 4.6.2.4 METHOD OF GROUNDWATER RECHARGE ASSESSMENT

Groundwater recharge is simply the quantity of water (principally atmospheric water) which infiltrates the saturated zone of groundwater occurrence. The level of groundwater recharge is dependent on the atmospheric precipitation, Surface run-off, evapotranspiration, soil moisture and seepage/ hydrologic classification characteristics of soils that constitute the unsaturated zone. The mean annual precipitation in the study area was determined by obtaining the average value of an eighty-four (84-year) rainfall record of Niger Delta weather belt covering Ibusa. The record (which ranges from 1931-2015) was archived by Nigeria Meteorological Agency (NIMET) and sourced by Adejuwon (2012). The hydrologic soil classification was achieved based on Particle Size Distribution (PSD) Analysis which revealed the soils of the unsaturated zone had over 52% sand content with significant proportions of silts and clays. These descriptions were typical of hydrologic soils of group B characteristics.

From the Hydrologic perspective, the quantification of surface run-off and evapo-tanspiration is subject to large uncertainties and errors hence groundwater recharge assessment is centered on estimations using empirical equations. One of the most reliable of them all is that of Williams and Kissel (1991) which incorporates precipitation and soil hydrologic classification as shown below:

$R = [\,(P-15.05)^2 / (P+22.57)]$……..1

Where:

R= Groundwater recharge

P = mean Annual Rainfall of the area in inches (=108.30 inches or 2750mm)

NB: The above equation is only applicable to group B soils

### 4.6.3 Ground Water Quality

The quality of any water resources is its suitability for the intended use. This thus, is a function of the physical, chemical and biological (bacteriological) characteristics of the water which in turn depends on the geology of the area and impacts of human activities. The laboratory analysis results of the groundwater samples obtained from these boreholes and the community portable water are presented in **Table 4.7 – Table 4.8**.

#### 4.6.3.1 Physico-chemical Properties of Ground water quality

**pH**

The parameter pH (negative base-10 logarithm of hydrogen ion activity in moles per liter) is one of the most fundamental water-quality parameters. It is easily measured, indicates whether water will be corrosive or will precipitate scale, determines the solubility and mobility of most dissolved constituents, and provides a good indication of the types of minerals groundwater has reacted with as it flows from recharge to discharge areas or sample sites. For these reasons it is one of the most important parameters that describe groundwater quality.

The groundwater exhibited acidic characteristics, with pH values of 4.10 (BH1), 5.13 (BH2) and 5.34 (Control), giving a mean value of 4.62 ± 0.73. These values are considerably below the FMEnv and DPR EGASPIN permissible limits of 6.5–8.5 and 6.5–9.2, respectively **(Table 4.7)**.

The acidic nature of the groundwater is typical of many aquifers in the Niger Delta where organic-rich soils, peat deposits, acid sulphate soils, high rainfall, natural carbon dioxide dissolution and humic substances contribute to groundwater acidity. Acidic groundwater increases the mobility and solubility of metals, potentially enhancing corrosion of metallic pipes and plumbing systems. Although heavy metals were largely absent in the analysed samples, prolonged exposure to acidic groundwater may increase future metal dissolution if metallic infrastructure is introduced. From an ESMP perspective, groundwater pH represents the principal parameter requiring routine monitoring throughout the project lifecycle.

**Table 4.7: Physio - Chemical Properties of Groundwater Sample within the Proposed Project Area**

| PARAMETERS | | BH 1 | BH 2 | BH CONTROL | MEAN±STDV | RANGE | FMENV | DPR EGASPIN |
|---|---|---|---|---|---|---|---|---|
| | LATITUDE | 6°10'3.75"N | 6° 9'58.66 N | 6°10'1.92"N | | | | |
| | LONGITUDE | 6°35'10.39"E | 6°35'11.17 E | 6°35'28.81"E | | | | |
| pH | | 4.1 | 5.13 | 5.34 | 4.615±0.728 | 4.1-5.13 | 6.5-8.5 | 6.5 – 9.2 |
| Temperature (ºC) | | 30.2 | 30.1 | 29.7 | 30.15±0.071 | 30.1-30.2 | 25.0-30 | <30.0 |
| TDS (mg/l) | | 34.5 | 21.46 | 6.38 | 27.98±9.221 | 21.46-34.5 | 500 | 2000 |
| EC (µS/cm) | | 66.73 | 42.51 | 12.4 | 54.62±17.126 | 42.51-66.73 | | |
| Colour (LCU) | | 2 | 2 | 1 | 2±0 | 2-2 | | |
| Turbidity (NTU) | | 0.36 | 0.28 | 0.19 | 0.32±0.057 | 0.28-0.36 | 5 | |
| TSS (mg/l) | | 6.0 | 5.0 | 3.0 | 5.5±0.707 | 5.0-6.0 | | 1.5 |
| Total Hardness (mg/l) | | 5.88 | 3.92 | 1.42 | 4.9±1.386 | 3.92-5.88 | | |
| DO (mg/l) | | 5.2 | 5.4 | 5.5 | 5.3±0.141 | 5.2-5.4 | >5.0 | |
| BOD (mg/l) | | 1.2 | 0.9 | 0.7 | 1.05±0.212 | 0.9-1.2 | | |
| COD (mg/l) | | 2.80 | 2.10 | 1.63 | 2.45±0.495 | 2.10-2.80 | | |
| Chloride (mg/l) | | 4.686 | 3.749 | 1.406 | 4.2175±0.663 | 3.749-4.686 | | |
| Salinity (mg/l) | | 8.744 | 6.995 | 2.623 | 7.8695±1.237 | 6.995-8.744 | | |
| Nitrate (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | 0-0 | 10mg/l | 10mg/l |
| Nitrite (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | 0-0 | | |
| $SO_4^{2-}$ (mg/l) | | 0.25 | 0.13 | 0.09 | 0.19±0.085 | 0.13-0.25 | | |

| **PARAMETERS** | | **BH 1** | **BH 2** | **BH CONTROL** | **MEAN±STDV** | **RANGE** | **FMENV** | **DPR EGASPIN** |
|---|---|---|---|---|---|---|---|---|
| | **LATITUDE** | 6°10'3.75"N | 6° 9'58.66 N | 6°10'1.92"N | | | | |
| | **LONGITUDE** | 6°35'10.39"E | 6°35'11.17 E | 6°35'28.81"E | | | | |
| $PO_4^3$ (mg/l) | | <0.01 | <0.01 | <0.01 | <0.01 | 0-0 | | |
| $NH_4$ (mg/l) | | <0.01 | <0.01 | <0.01 | <0.01 | 0-0 | | |
| Na (mg/l) | | 1.13 | 1.09 | 1.24 | 1.11±0.028 | 1.09-1.13 | | |
| K (mg/l) | | 0.05 | 0.07 | 0.03 | 0.06±0.014 | 0.05-0.07 | | |
| Ca (mg/l) | | 1.435 | 0.894 | 0.313 | 1.1645±0.383 | 0.894-1.435 | | |
| Mg (mg/l) | | 0.56 | 0.412 | 0.156 | 0.486±0.105 | 0.412-0.56 | | |
| TPH (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | 0-0 | | |
| BTEX (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | 0-0 | | |
| THC (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | 0-0 | | |
| Fe (mg/l) | | 0.043 | 0.032 | 0.012 | 0.0375±0.008 | 0.032-0.043 | | |
| Zn (mg/l) | | 0.026 | 0.017 | 0.008 | 0.0215±0.006 | 0.017-0.026 | | |
| Pb (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Cd (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Cr (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Ni (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| V (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Hg (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Ba (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |
| Mn (mg/l) | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | |

Source: Field Data from proposed ESMP 500MT LPG Blending Plant Project Site 2026

**Temperature**

Groundwater temperature ranged from 30.10–30.20°C, with a mean of 30.15 ± 0.07°C. The values were close to the FMEnv limit (25–30°C) and only marginally exceeded the DPR guideline of less than 30°C.

The extremely low standard deviation indicates remarkable thermal stability within the aquifer, suggesting minimal anthropogenic thermal influence. The slight elevation is attributable to prevailing tropical climatic conditions rather than industrial activities.

**Total Dissolved Solids**

Total dissolved solids (TDS) are the sum of all dissolved chemicals in water, expressed as mg/L. TDS values are a general indicator of the suitability of groundwater for various uses (Mazor, 1991). The FMEnv and WHO has set a secondary drinking water of 500 mg/L total dissolved solids. Water having TDS values greater than 500 mg/L has an unpleasant taste and may stain objects or precipitate scale. The average TDS concentrations were 34.50, 21.46 and 6.38 mg/L for BH1, BH2 and the control, respectively, producing a mean of 27.98 ± 9.22 mg/L. These values are substantially below both the FMEnv (500 mg/L) and DPR (2000 mg/L) limits **(Table 4.7**).

**Electrical Conductivity (EC)**

Specific electrical conductance, also referred to as conductivity, is a measure of the ease with which water conducts an electrical current. It is an indirect measure of water quality and is proportional to total dissolved solids concentrations. Conductance or conductivity is reported in micromhos per centimeter at a standard temperature, µ usually 25°C, or the numerically equivalent micro siemens per centimeter (µS/cm) in the international system of units (Hem, 1985). Because conductance does not directly indicate water quality, there are no health or water-use standards based on this parameter. Electrical conductivity ranged between 42.51 and 66.73 µS/cm, with a mean value of 54.62 ± 17.13 µS/cm **(Table 4.7**). These values indicate extremely low ionic strength and confirm the fresh nature of the groundwater. The EC values closely correspond with the observed low TDS concentrations, demonstrating excellent consistency within the analytical dataset.

**Total Suspended Solids**

Suspended particulate mater is reported as total suspended solids (TSS). The TSS values ranged between 5 and 6 mg/L, with a mean of 5.50 ± 0.71 mg/L. These values exceed the FMEnv guideline value of 1.5 mg/L **(Table 4.7**). The elevated TSS likely reflects naturally occurring fine sediments associated with unconsolidated Niger Delta formations rather than pollution. Nevertheless, elevated suspended solids can increase turbidity if groundwater is disturbed and therefore warrant periodic monitoring. There is no health or cosmetic standards for total suspended solids in water. However, some metals and pesticides are preferentially absorbed onto or included in the matrix of suspended material, so water high in total suspended solids may also contain important amounts of metals that may have health or safety implications. Also, high amounts of suspended material can clog plumbing systems and stain clothing and water containers. Nigerian standard for drinking water quality recommends that TSS levels be less than 35 mg/L.

**Colour**

The groundwater samples collected from the proposed project site exhibited colour values ranging from 2–2 LCU, with a calculated mean concentration of 2.00 ± 0.00 LCU. The control borehole recorded the lowest colour value of 1 LCU, whereas both BH1 and BH2 recorded 2 LCU each, demonstrating negligible variation among the sampled boreholes and confirming the hydrogeochemical uniformity of the groundwater system **(Table 4.7**). The colour results indicate that groundwater within the project area possesses excellent visual quality and has not experienced deterioration from petroleum hydrocarbons, suspended sediments or other contaminants commonly associated with industrial development. This finding provides an important baseline against which future groundwater monitoring during project construction and operation can be evaluated.

**Turbidity**

The observed turbidity values within the proposed project area ranged between 0.19 and 0.36 NTU, with an overall mean concentration of 0.32 ± 0.06 NTU. The control borehole recorded the lowest turbidity (0.19 NTU), while BH1 exhibited the highest value (0.36 NTU) **(Table 4.7**).

Despite these slight variations, all measured values remain substantially below the FMEnv regulatory limit of 5 NTU, confirming excellent groundwater clarity.

The exceptionally low turbidity values also indicate the absence of significant suspended particulate matter, soil erosion products, microbial aggregates or colloidal materials that could impair groundwater quality. Such results reflect the effectiveness of the natural filtration processes occurring within the aquifer matrix and demonstrate that groundwater recharge is occurring without significant transport of suspended solids.

**Total Hardness**

Total hardness values obtained from the groundwater samples within the proposed project area ranged from 3.92 to 5.88 mg/L, with a mean concentration of 4.90 ± 1.39 mg/L. The control borehole recorded the lowest hardness value (1.42 mg/L), whereas BH1 exhibited the highest concentration (5.88 mg/L), indicating only minor natural variations within the aquifer **(Table 4.7**). Generally, the groundwater is classified as very soft water, reflecting the exceptionally low concentrations of dissolved calcium and magnesium ions.

### 4.6.3.2 Oxygen Demand Characteristics

***Dissolved Oxygen (DO)***

The measured dissolved oxygen concentrations within the proposed project area ranged from 5.20 to 5.40 mg/L, with an overall mean value of 5.30 ± 0.14 mg/L. The control borehole recorded the highest concentration (5.50 mg/L), while BH1 recorded the lowest (5.20 mg/L) **(Table 4.7**). Nevertheless, all measured values exceeded the recommended minimum concentration of 5.0 mg/L, indicating a well-oxygenated groundwater system.

***Biological Oxygen Demand (BOD)***

The groundwater samples within the proposed project area exhibited BOD values ranging between 0.90 and 1.20 mg/L, with a mean concentration of 1.05 ± 0.21 mg/L. The control borehole recorded the lowest value (0.70 mg/L), while BH1 recorded the highest (1.20 mg/L) **(Table 4.7**). These concentrations are extremely low and demonstrate negligible biodegradable organic contamination within the groundwater system.

***Chemical Oxygen Demand (COD)***

The measured COD values within the proposed project area ranged between 2.10 and 2.80 mg/L, with a mean concentration of 2.45 ± 0.50 mg/L. The control borehole recorded the lowest value (1.63 mg/L), while BH1 exhibited the highest concentration (2.80 mg/L) **(Table 4.7**). Despite these minor differences, all measured values remain characteristically low and indicate excellent groundwater quality.

**4.6.3.3 Heavy Metals in Groundwater**

The assessment of heavy metal status is because of the concerns relating to their presence in water. Such concerns are toxicity, bioaccumulation and hazards to human health (GEMS 1992). The heavy metals concentration in groundwater of the study area is presented in **Table 4.7**. Iron (0.0375 ± 0.008 mg/L) and zinc (0.0215 ± 0.006 mg/L) occurred at very low concentrations, while lead, cadmium, chromium, nickel, mercury, manganese, vanadium and barium were below equipment detection limit of <0.001mg/L.

The absence of toxic heavy metals demonstrates that groundwater quality has not been adversely influenced by industrial activities and presents no current toxicological concern.

**4.6.3.4 Major Ions and Nutrients**

***Chloride ($Cl^-$)***

The groundwater samples collected from the proposed 500 MT Liquefied Petroleum Gas (LPG) Blending Plant site recorded chloride concentrations ranging from 3.749 to 4.686 mg/L, with an overall mean concentration of 4.22 ± 0.66 mg/L. BH1 recorded the highest concentration (4.686 mg/L), BH2 recorded 3.749 mg/L, while the control borehole contained the lowest concentration (1.406 mg/L) **(Table 4.7**). The relatively small standard deviation demonstrates limited spatial variability and indicates a fairly homogeneous groundwater chemistry across the study area. The measured chloride concentrations are extremely low and remain far below the FMEnv permissible limit of 250 mg/L and the DPR guideline value of 600 mg/L, indicating excellent groundwater quality with respect to chloride. The close similarity between the project boreholes and the control borehole further confirms that chloride concentrations represent the natural hydrochemical characteristics of the aquifer rather than anthropogenic contamination.

***Salinity***

The observed salinity values within the proposed project area ranged between 6.995 and 8.744 mg/L, with a mean concentration of 7.87 ± 1.24 mg/L. BH1 recorded the highest salinity, while the control borehole exhibited the lowest concentration **(Table 4.7**).

***Sulphate ($SO_4^{2-}$)***

The Sulphate concentrations varied between 0.13 and 0.25 mg/L, with an overall mean concentration of 0.19 ± 0.09 mg/L. BH1 recorded the highest concentration, whereas the control borehole contained the lowest value **(Table 4.7**). These concentrations are substantially below the FMEnv and DPR permissible limit of 250 mg/L, indicating complete compliance with regulatory standards.

***Sodium ($Na^+$)***

Sodium concentrations within the proposed project area ranged from 1.09 to 1.13 mg/L, with an average mean concentration of 1.11 ± 0.03 mg/L. The control borehole recorded a slightly higher concentration (1.24 mg/L), while the project boreholes exhibited very similar values, indicating excellent consistency across the study area **(Table 4.7**). These concentrations are significantly below the FMEnv guideline value of 200 mg/L, confirming that sodium does not pose any health or operational concern. The very low sodium concentration also indicates the absence of saline intrusion and demonstrates that groundwater mineralization remains extremely limited.

***Potassium ($K^+$)***

Potassium concentrations within the proposed project area varied between 0.05 and 0.07 mg/L, producing a mean concentration of 0.06 ± 0.01 mg/L. The control borehole recorded a slightly lower value (0.03 mg/L), while both project boreholes contained similarly low concentrations **(Table 4.7**). The extremely low potassium concentrations indicate negligible contribution from fertilizer application, sewage contamination or industrial wastes. Since potassium is generally retained within soil minerals through ion exchange processes, its occurrence in groundwater at such low concentrations is typical of uncontaminated aquifers.

***Calcium ($Ca^{2+}$)***

Calcium concentrations within the proposed project plant area ranged from 0.894 to 1.435 mg/L, with an overall mean concentration of 1.16 ± 0.38 mg/L. BH1 recorded the highest concentration, whereas the control borehole exhibited the lowest concentration (0.313 mg/L) **(Table 4.7**). The measured concentrations are considerably below international drinking water guideline values and therefore present no adverse health or operational implications. These values are exceptionally low and explain the very soft nature of the groundwater observed during hardness assessment. The low calcium concentrations reflect limited dissolution of carbonate minerals within the predominantly sandy aquifer and indicate minimal groundwater mineralization.

***Magnesium ($Mg^{2+}$)***

Magnesium concentrations ranged between 0.412 and 0.560 mg/L, with an overall mean value of 0.49 ± 0.11 mg/L. The control borehole contained the lowest concentration (0.156 mg/L), while BH1 exhibited the highest concentration **(Table 4.7**). The low magnesium concentrations complement the observed calcium concentrations and collectively explain the exceptionally low total hardness measured within the groundwater system. These values are characteristic of freshwater aquifers with limited mineral dissolution and confirm the weakly mineralized nature of the groundwater.

**4.6.3.5 Nutrient Characteristics**

***Nitrate ($NO_3^-$)***

Nitrate was not detected in any of the groundwater samples within the proposed project area, with a mean concentration of <0.001 mg/L, remaining well below the FMEnv and DPR permissible limit of 10 mg/L **(Table 4.7**). The complete absence of nitrate indicates that the groundwater has not been affected by agricultural fertilizer application, septic tank leakage, sewage infiltration or decomposition of nitrogenous organic matter. The similarity between the project boreholes and the control location confirms that nitrate contamination is absent throughout the study area.

***Nitrite ($NO_2^-$)***

Nitrite concentrations were also below analytical detection limits in all groundwater samples within the proposed project area (**Table 4.7**). Nitrite is generally unstable in oxygenated groundwater and is rapidly oxidized to nitrate under natural conditions. Its absence confirms that no recent contamination from sewage, industrial effluents or partially oxidized nitrogen compounds has occurred within the aquifer.

***Phosphate ($PO_4^{3-}$)***

Phosphate concentrations were below laboratory detection limits (<0.01 mg/L) in all sampled boreholes within the proposed project area (**Table 4.7**). Phosphate is usually strongly adsorbed onto soil particles and therefore occurs only at very low concentrations in uncontaminated groundwater.

***Ammonium ($NH_4^+$)***

Ammonium concentrations were likewise below analytical detection limits (<0.01 mg/L) throughout the study area (**Table 4.7**). The absence of ammonium indicates that reducing conditions, sewage contamination and decomposition of organic wastes are not influencing groundwater quality.

**Organic Compounds**

The Total Petroleum Hydrocarbon (TPH), Total Hydrocarbon Content (THC) and BTEX compounds were not detected in any groundwater sample (**Table 4.7**). These findings are particularly significant because they establish that the baseline groundwater quality has not been impacted by petroleum contamination prior to project commencement, providing an excellent reference dataset for future compliance monitoring during plant operation.

### 4.6.3.6 Microbiological Characteristics of Groundwater Samples

The microbial status of ground water samples in study area as expressed in their values are presented in **Table 4.8**.

***Total Coliform Count (TCC)***

The groundwater samples collected from the proposed 500 MT Liquefied Petroleum Gas (LPG) Blending Plant recorded Total Coliform Counts (TCC) ranging between 7 and 11 MPN/100 mL, with a mean concentration value of 9.00 ± 2.83 MPN/100 mL. BH1 recorded the highest count (11 MPN/100 mL), BH2 recorded 7 MPN/100 mL, while the control borehole exhibited the lowest count (4 MPN/100 mL) **(Table 4.8**).

**Table 4.8: Microbiological Characteristics of Ground water Samples in Proposed Project Area**

| PARAMETERS | | BH 1 | BH 2 | BH CONTROL | MEAN±STDV | RANGE | FMENV | DPR EGASPIN |
|---|---|---|---|---|---|---|---|---|
| | LATITUDE | 6°10'3.75"N | 6° 9'58.66 N | 6°10'1.92"N | | | | |
| | LONGITUDE | 6°35'10.39"E | 6°35'11.17 E | 6°35'28.81"E | | | | |
| Total Coliform Count (MPN/100ml) | | 11 | 7 | 3 | 9±2.828 | 7-11 | | |
| Feacal Coliform Count (MPN/100ml) | | 0 | 0 | 0 | 0±0 | 0-0 | | |

**Source:** Field Data from Proposed ESMP Rainoil 500MT LPG Blending Plant Project Site, 2026

***Feacal Coliform Count (FCC)***

The laboratory analysis showed that FRainoil Limited/Rainoil Gas Limitedal Coliform Counts (FCC) were not detected (ND) in all groundwater sample (**Table 4.8**). The absence of variability among all sampling locations demonstrates complete microbiological consistency throughout the study area.

## 4.7 HYDROBIOLOGICAL STUDIES

Hydrobiological studies were not undertaken as part of the baseline environmental investigations for the proposed Mini 500 MT Liquefied Petroleum Gas (LPG) Blending Plant Project because no river, stream, creek, lake, pond, wetland, reservoir or other permanent surface water body was identified within a five (5) kilometer radius of the proposed project site during the environmental reconnaissance survey. Consequently, there was no aquatic ecosystem capable of supporting representative hydrobiological communities that could be scientifically sampled and evaluated.

Hydrobiological investigations are specifically designed to assess the composition, abundance and ecological status of aquatic organisms, including phytoplankton, zooplankton, benthic macroinvertebrates, aquatic macrophytes and fish communities. These organisms are recognized as biological indicators of aquatic ecosystem health because they respond to changes in water quality, sediment characteristics and habitat conditions. Therefore, hydrobiological assessments are only meaningful where natural aquatic habitats exist and where project activities have a realistic pathway to influence those ecosystems.

For the proposed LPG blending facility, detailed field reconnaissance confirmed that the project area is located on terrestrial land without any perennial or seasonal surface water body within the defined 5-km study radius. In the absence of rivers or other aquatic habitats, the environmental conditions necessary to sustain stable aquatic biological communities are not present. Consequently, there were no representative aquatic receptors from which phytoplankton, zooplankton, benthic organisms or fish populations could be sampled to establish a scientifically valid ecological baseline.

The conceptual site model developed for this ESMP indicates that the principal environmental receptors associated with the proposed development are terrestrial soils, groundwater, ambient air, vegetation, wildlife and nearby human populations rather than aquatic ecosystems. Consequently, the baseline studies appropriately focused on soil quality, groundwater quality, ambient air quality, meteorological conditions, noise, terrestrial ecology and socio-economic conditions, which represent the environmental components most likely to interact with project activities.

## 4.8 Vegetation and Wildlife Studies

### 4.8.1 Vegetation Studies

Vegetation is an important component of the biophysical environment and serves as an indicator of ecosystem health, biodiversity, and ecological integrity (Sharma, 2019). The vegetation assessment was conducted as part of the Environmental and Social Management Plan (ESMP) for the proposed Mini (500 MT) LPG Blending Plant located along Ogwashi–Igbuzor Road, Ogbeowele Quarters, Ibusa, Oshimili North Local Government Area of Delta State. The assessment was undertaken to document the floristic composition, vegetation structure, abundance, conservation status, and ecological significance of plant species within the project area and its immediate surroundings. The study area falls within the derived savannah ecological zone of southern Nigeria, where continuous anthropogenic disturbances have modified the original lowland rainforest vegetation into a mosaic of farmland, secondary forest, and derived savannah. Human activities such as farming, fuelwood harvesting, bush clearing, settlement expansion, and periodic burning have contributed significantly to vegetation alteration within the area. The farmland habitat constitutes the dominant vegetation type around the proposed project site and is characterized by intensive cultivation of food crops. The most common cultivated species recorded include cassava (*Manihot esculenta*), okra (*Abelmoschus esculentus*), maize (*Zea mays*), groundnut (*Arachis hypogaea*), and other agricultural crops. Frequent cultivation, weeding, and harvesting have resulted in continuous disturbance, encouraging the proliferation of fast-growing herbs and ruderal species. The secondary forest habitat comprises scattered indigenous trees interspersed with shrubs, herbs, climbers, and economically important plant species. Tree species such as African Oil Palm (*Elaeis guineensis*), mango (*Mangifera indica*), African silk-cotton (*Ceiba pentandra*), *Albizia spp*., and Yellow Sterculia (*Sterculia oblonga*) occur sparsely throughout the area. These woody species provide ecological services including shade, habitat for wildlife, soil stabilization, carbon sequestration, and sources of food, timber, fuelwood, medicine, and non-timber forest products. The derived savannah habitat consists predominantly of grasses, herbs, shrubs, and scattered trees adapted to repeated disturbance.

Common grasses and herbaceous plants include Guinea Grass (*Panicum maximum*), Goat Weed (*Ageratum conyzoides*), Coat Buttons (*Tridax procumbens*), Siam Weed (*Chromolaena odorata*), Mexican sunflower (*Tithonia diversifolia*), and numerous medicinal species commonly utilized by local communities. Generally, the vegetation reflects a landscape under continuous anthropogenic influence with secondary successional characteristics rather than pristine natural forest as observed during the field data gathering exercises that took place on the 26th and 27th day of June 2026 (**Plate 4.1-4.4**).

**Plate 4.1: Picture showing the derived savannah habitat of the project area.**

**Plate 4.2: Picture showing farmland habitat of the project area bordering with secondary forest.**

**Plate 4.3: Picture showing farmland habitat of the project area with stands of cultivated crops.**

**Plate 4.4: Picture showing the secondary forest habitat of the project area.**

**Study methodology**

Vegetation sampling was carried out using a 40 m × 40 m line transect sampling technique. Four sampling plots were established in the four cardinal directions (North, South, East, and West) within the proposed project area to adequately capture vegetation variability. In addition, one control plot of similar dimensions was established outside the project area within a comparable vegetation type to serve as a reference for evaluating project-related impacts, accounting for 8,000 $m^2$, representing 0.8 hectares under study. Within each transect, all vascular plant species were identified to species level where possible (Gillison, 2000a; Thomas *et al*., 1997). Data collected included botanical name, common name, family, growth habit (life form), indigenous uses, conservation status, and abundance. Species identification was based on standard botanical references and field experience (Gillison, 2000a; Thomas *et al*., 1997).

**Floristic Composition**

The study recorded a total of 90 flora species in 41 taxonomic families were sampled around the project area. The vegetation survey recorded a relatively high diversity of plant species comprising cultivated crops, medicinal plants, ornamentals, grasses, shrubs, trees, climbers, creepers, runners, and epiphytes belonging to numerous botanical families. The checklist indicates that the flora is dominated by members of Fabaceae, Poaceae, Euphorbiaceae, Malvaceae, Asteraceae, Amaranthaceae, Cyperaceae, Araceae, Mimosaceae, and Anacardiaceae. Most of these families are typical of secondary vegetation and disturbed tropical ecosystems such as those of the project area (Abe' *et al.*, 1995; Sankaran *et al.*, 2008).

**Plant Life Form Analysis**

The plant life form distribution in the project area cut across different growth forms that befits the project habitat description as herbs dominated the project area with 39 flora, accounting for 43.33% of the total sampled flora species for the project. This was followed by trees with 23 species representing 25.56%. Shrubs recorded a total of 16 species accounting for 17.78%, runners recorded 4 species representing 4.44%, climbers recorded 3 species accounting for 3.33%, creepers recorded 2 species accounting for 2.22% while 1 species each were recorded for epiphytes, ferns and lianas representing 1.11% respectively. The dominance of herbs over other life forms indicates an ecosystem disturbed by anthropogenic activities. The vegetation exhibited a mixture of several plant growth forms. Herbs formed the largest proportion of the recorded flora. They include species such as: *Panicum maximum*, *Ageratum conyzoides*, *Chromolaena odorata*, *Aspillia africana*, *Tridax procumbens*, *Sida acuta*, *Emilia sonchifolia*, and *Amaranthus spp.* Their dominance reflects frequent land disturbance associated with farming and other human activities (Abe' *et al*., 1995; Sankaran *et al*., 2008) (**Plate 4.5**).

*Chromolaena odorata* (Siam Weed)

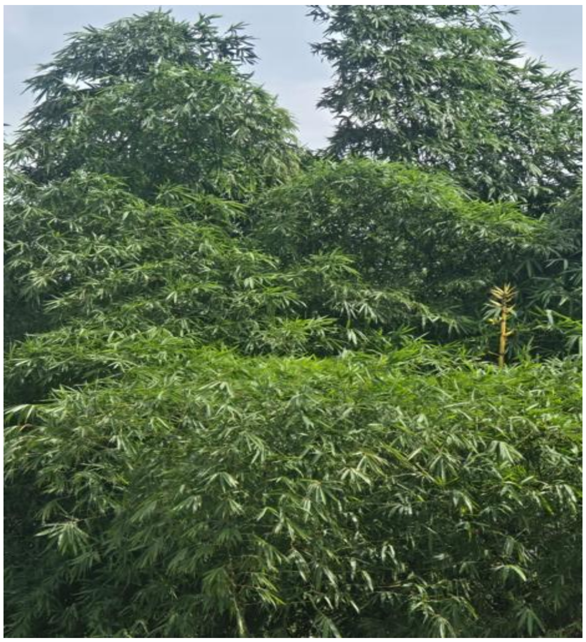
*Panicum maximum* (Guinea Grass)

**Plate 4.5: Some pictures showing the most abundant herbs sampled in the project area.**

The Tree species sampled in the project area were moderately represented and included: *Mangifera indica*, *Elaeis guineensis*, *Ceiba pentandra*, *Albizia zygia*, *Psidium guajava*, *Anthocleista djalonensis*, *Newbouldia laevis*, *Anthocleista procera*, *Bambusa vulgaris*, and *Anthocleista vogelii*.

*Elaeis guineensis* (African Oil Palm)

*Albizia adianthifolia* (Flat-crown)



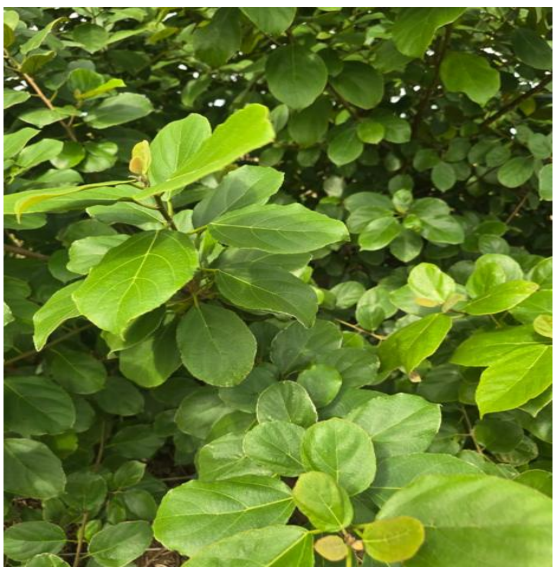
*Bambusa vulgaris* (Common Bamboo)

**Plate 4.6: Pictures showing some of the tree species sampled around the project area.**

These species are primarily economic trees retained by local farmers, in addition to their ecosystem service advantage.

The Shrubs were also well represented and included: *Alchornea cordifolia*, *Cnestis ferruginea*, *Securinega virosa* and *Alchornea laxiflora* etc. Most shrub species are among the species with great medicinal importance.

*Lonchocarpus sericeus* (Lilac Tree) *Securinega virosa* (White Berry Bush)



*Ficus exasperata* (Forest Sandpaper Fig) *Millettia aboensis* (Aboens Millettia)

**Plate 4.7: Pictures showing some of the shrubs sampled around the project area.**

**Species Abundance Analysis**

The analysis of the project area revealed that the highest number of individuals per sampling point was recorded in VG.C1 with 5321 individuals. This was followed with VG.4 with 1649 individuals, VG.2 with 1596 individuals, VG.3 with 1421 individuals while VG.1 the least recorded 1310 individuals in decreasing order of individuals.

The checklist indicates that the vegetation is dominated by common agricultural crops and ruderal species for which some possess extreme economic values to the locals around the project area.

The most abundant species recorded include: *Arachis hypogaea* (Groundnut), *Chromolaena odorata* (Siam Weed), *Aspilia africana* (African Marigold), *Ageratum conyzoides* (Billy Goat Weed), *Panicum maximum* (Guinea Grass), *Zea mays* (Maize), *Securinega virosa*, *Tithonia diversifolia*, and *Tridax procumbens*. These species exhibited the highest total abundance due to continuous farming and disturbance (IUCN, 2023; IUCN, 2019; Ahern *et al.*, 2001; Ahern *et al*., 2000). Conversely, species with very low abundance included: *Carica papaya*, *Spondias mombin*, *Ceiba pentandra* and *Albizia ferruginea* et cetera. These woody species occurred most times as isolated individuals retained on farms. The dominance of herbs over woody species indicates an ecosystem in an early to intermediate stage of ecological succession.

**Conservation Status Analysis**

The conservation assessment indicates that the flora of the study area is largely composed of species categorized as: Least Concern (LC), representing the majority of recorded species. Not Evaluated (NE), several indigenous and cultivated species have not yet been assessed by the IUCN (IUCN, 2023; IUCN, 2019). Data Deficient (DD), a few species lack sufficient information for conservation assessment. Vulnerable (VU), only a very small number of species were classified as Vulnerable (Gretchen *et al.*, 1997; IUCN, 2023; IUCN, 2019; Ahern *et al.*, 2001; Ahern *et al*., 2000). Importantly: No Critically Endangered (CR) species were recorded for the project. No Endangered (EN) species were encountered. No Endemic or legally protected species were observed within the proposed project footprint. The presence of predominantly Least Concern, Not Evaluated, and cultivated species suggests that the proposed project site possesses low conservation sensitivity.

**Ecological Significance**

Although the vegetation has been substantially modified by human activities, it still provides important ecosystem services, including: soil stabilization and erosion control, carbon sequestration, habitat for insects, birds, reptiles, and small mammals, pollinator support, provision of medicinal plants used by local communities, food crops and economically valuable tree species and fuelwood, timber, and non-timber forest products (Sarukhán and Whyte, 2005; IFC, 2012; Gretchen *et al.*, 1997). The secondary forest patches also serve as refugia for indigenous plant species within an otherwise highly disturbed agricultural landscape.

**Table 4.9: Comprehensive checklist of the flora species sampled around the project area.**

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| 1. | *Asystasia gangetica* | Chinese Violet | Herb | Acanthaceae | Fodder, Medicinal | NA | 24 | 56 | 6 | 43 | 129 | 55 |
| 2. | *Dracaena arborea* | Dracaena | Tree | Agavaceae | Boundary plant | NA | 2 | 4 | 3 | 3 | 12 | 12 |
| 3. | *Alternanthera bettzickiana* | Calico-plant | Herb | Amaranthaceae | Fodder, and medicinal | NA | 43 | 35 | 0 | 27 | 105 | 67 |
| 4. | *Alternanthera sessilis* | Sessile Joyweed | Herb | Amaranthaceae | Fodder, Medicinal | LC | 22 | 33 | 14 | 20 | 89 | 82 |
| 5. | *Amaranthus spinosus* | Thorny Pigweed | Herb | Amaranthaceae | Food, Medicinal | NA | 16 | 27 | 0 | 24 | 67 | 47 |
| 6. | *Cyathula prostrata* | Pasture Weed | Herb | Amaranthaceae | Medicinal | NA | 20 | 42 | 20 | 35 | 117 | 72 |
| 7. | *Mangifera indica* | Mango | Tree | Anacardiaceae | Fruit, firewood, shade tree | DD | 0 | 1 | 0 | 2 | 3 | 6 |
| 8. | *Spondias mombin* | Yellow Mombin | Tree | Anacardiaceae | Fruit, vegetable, timber, firewood and boundary plant | LC | 7 | 11 | 0 | 10 | 28 | 16 |
| 9 | *Alstonia* | Pattern | Tre | Apocy | Timber, firewood, medicine | LC | 14 | 4 | 11 | 6 | 35 | 22 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| . | *boonei* | wood or Emien | e | naceae | | | | | | | | |
| 10. | *Rauvolfia vomitoria* | Poison Devil's-pepper | Shrub | Apocynaceae | Medicine and firewood | LC | 11 | 0 | 28 | 16 | 55 | 13 |
| 11. | *Caladium bicolor* | Heart of Jesus | Herb | Araceae | Ornamental and medicine | NA | 0 | 7 | 3 | 5 | 15 | 13 |
| 12. | *Xanthosoma sagittifolium* | Elephant Ear | Herb | Araceae | Food and medicine | NA | 0 | 4 | 0 | 27 | 31 | 20 |
| 13. | *Elaeis guineensis* | African Oil Palm | Tree | Arecaceae | Medicinal, fruit, nuts, fodder, fibres, fence, broom, roof, basket and frames | LC | 16 | 22 | 15 | 11 | 64 | 58 |
| 14. | *Ageratum conyzoides* | Billy Goat Weed | Herb | Asteraceae | Fodder, Medicinal | LC | 47 | 55 | 37 | 126 | 265 | 68 |
| 15. | *Aspillia africana* | African Marigold | Herb | Asteraceae | Fodder, Medicinal | NA | 0 | 42 | 103 | 85 | 230 | 125 |
| 16. | *Chromolaena odorata* | Siam Weed | Herb | Asteraceae | Medicinal | NA | 18 | 46 | 12 | 133 | 209 | 178 |
| 17. | *Emilia sonchifolia* | Red Tasselflower | Herb | Asteraceae | Medicinal | NA | 0 | 20 | 2 | 11 | 33 | 54 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| 18. | *Synedrella nodiflora* | Nodeweed | Herb | Asteraceae | Medicinal and Food | NA | 33 | 40 | 17 | 21 | 111 | 131 |
| 19. | *Tithonia diversifolia* | Tree Marigold | Herb | Asteraceae | Ornamental and medicine | NA | 88 | 0 | 58 | 36 | 182 | 178 |
| 20. | *Tridax procumbens* | Coatbuttons or Tridax Daisy | Herb | Asteraceae | Medicinal | NA | 0 | 6 | 23 | 42 | 71 | 78 |
| 21. | *Diplazium species* | Common Glade Fern | Fern | Athyraceae | Vegetable | NA | 15 | 32 | 7 | 7 | 61 | 81 |
| 22. | *Newbouldia laevis* | Boundary Tree | Tree | Bignoniaceae | Medicinal, boundary plant, spiritual plant, trap making and firewood | NA | 7 | 0 | 1 | 0 | 8 | 9 |
| 23. | *Carica papaya* | Pawpaw | Tree | Caricaceae | Medicine and fruit | DD | 1 | 2 | 1 | 0 | 4 | 3 |
| 24. | *Cleome rutidosperma* | Fringed Spider Flower | Herb | Cleomaceae | Medicinal | NA | 17 | 34 | 21 | 8 | 80 | 15 |
| 25. | *Combretum racemosum* | Bushwillows | Shrub | Combretaceae | Roots serve as medicine for ulcer | NA | 12 | 23 | 31 | 27 | 93 | 83 |
| 26 | *Commelina benghalens* | Day Flower | Runner | Commelinace | Medicinal | LC | 45 | 23 | 48 | 37 | 153 | 67 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| . | *is* | or wandering Jew | | ae | | | | | | | | |
| 27. | *Commelina diffusa* | Climbing Dayflower | Runner | Commelinaceae | Medicinal | LC | 38 | 16 | 22 | 11 | 87 | 76 |
| 28. | *Palisota hirsuta* | Swollen Knee | Herb | Commelinaceae | Medicinal | NA | 0 | 23 | 16 | 0 | 39 | 54 |
| 29. | *Cnestis ferruginea* | Cnestis | Shrub | Connaraceae | Ornamental and medicine | NA | 0 | 12 | 11 | 15 | 38 | 48 |
| 30. | *Ipomoea batatas* | Sweet Potato | Runner | Convolvulaceae | Food and energy | DD | 58 | 72 | 55 | 3 | 188 | 211 |
| 31. | *Ipomoea indica* | Blue Morning Glory | Runner | Convolvulaceae | Medicinal | DD | 16 | 23 | 5 | 24 | 68 | 50 |
| 32. | *Costus afer* | Spiral Ginger | Herb | Costaceae | Medicine and food | NA | 17 | 12 | 0 | 8 | 37 | 52 |
| 33. | *Luffa cylindrica* | Loofah Gourd | Climber | Cucurbitaceae | Medicinal and local sponge | NA | 15 | 0 | 11 | 0 | 26 | 23 |
| 34. | *Cyperus brevifolius* | Kyllinga Brevifolius | Herb | Cyperaceae | Medicinal | LC | 0 | 21 | 7 | 17 | 45 | 54 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| 35. | *Scleria depressa* | Nutrushes | Herb | Cyperaceae | Fodder | LC | 22 | 0 | 17 | 0 | 39 | 67 |
| 36. | *Scleria naumanniana* | Nutrushes | Herb | Cyperaceae | Fodder | LC | 7 | 13 | 22 | 0 | 42 | 66 |
| 37. | *Alchornea cordifolia* | Christmas Bush | Shrub | Euphorbiaceae | Medicine and firewood | LC | 32 | 21 | 12 | 26 | 91 | 53 |
| 38. | *Alchornea laxiflora* | Venda Bead-string | Shrub | Euphorbiaceae | Medicinal and food wrapping | LC | 0 | 0 | 8 | 15 | 23 | 31 |
| 39. | *Euphorbia heterophylla* | Milkweed | Herb | Euphorbiaceae | Medicinal | NA | 6 | 13 | 0 | 4 | 23 | 77 |
| 40. | *Euphorbia hirta* | Garden Spurge | Herb | Euphorbiaceae | Medicinal | NA | 0 | 11 | 19 | 0 | 30 | 47 |
| 41. | *Manihot esculenta* | Cassava | Shrub | Euphorbiaceae | Food and energy, vegetable | DD | 126 | 87 | 122 | 184 | 519 | 466 |
| 42. | *Phyllanthus amarus* | Carry Me Seed | Herb | Euphorbiaceae | Medicinal | NA | 15 | 23 | 17 | 36 | 91 | 42 |
| 43. | *Clitoria ternatea* | Butterfly Pea | Liana | Fabaceae | Medicinal and ornamental | NA | 7 | 18 | 3 | 8 | 36 | 28 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| 44. | *Albizia adianthifolia* | Flat-crown | Tree | Fabaceae | Timber, construction, firewood and medicine | LC | 1 | 5 | 11 | 7 | 24 | 18 |
| 45. | *Arachis hypogaea* | Groundnut | Herb | Fabaceae | Food and medicine | NA | 67 | 77 | 123 | 89 | 356 | 289 |
| 46. | *Calopogonium mucunoides* | Calopo | Herb | Fabaceae | Fodder | NA | 13 | 0 | 16 | 24 | 53 | 19 |
| 47. | *Lonchocarpus sericeus* | Lilac Tree | Shrub | Fabaceae | Medicine and firewood | LC | 15 | 7 | 0 | 22 | 44 | 34 |
| 48. | *Millettia aboensis* | Aboens Milletia | Shrub | Fabaceae | Trap making, fence, medicine and firewood | LC | 0 | 4 | 7 | 12 | 23 | 7 |
| 49. | *Napoleonaea vogelii* | Napoleon's Hat | Shrub | Lecythidaceae | Fruit, trap making, medicine and fuelwood | LC | 5 | 3 | 7 | 11 | 26 | 17 |
| 50. | *Anthocleista djalonensis* | Cabbage Tree | Tree | Loganiaceae | Medicine, timber and firewood | LC | 12 | 8 | 0 | 2 | 22 | 34 |
| 51. | *Anthocleista procera* | Carbage Tree | Tree | Loganiaceae | Medicine, timber and firewood | NA | 0 | 6 | 5 | 11 | 22 | 19 |
| 52. | *Anthocleista vogelii* | Cabbage Tree | Tree | Loganiaceae | Medicine, timber and firewood | LC | 23 | 0 | 0 | 0 | 23 | 43 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| 53. | *Tapinanthus globiferus* | Mistletoe | Epiphytes | Loranthaceae | Excellent medicinal plant | VU | 0 | 4 | 0 | 14 | 18 | 22 |
| 54. | *Abelmoschus esculentus* | Okra | Shrub | Malvaceae | Food and medicine | NA | 45 | 66 | 56 | 23 | 190 | 177 |
| 55. | *Ceiba pentandra* | White silk-Cotton Tree | Tree | Malvaceae | Timber, vegetable and cotton wool | LC | 1 | 0 | 5 | 16 | 22 | 14 |
| 56. | *Corchorus tridens* | Wild Jute | Herb | Malvaceae | Vegetable and medicine | NA | 18 | 11 | 5 | 23 | 57 | 61 |
| 57. | *Glyphaea brevis* | Monach | Shrub | Malvaceae | Cain, vegetable, fence and trap making | LC | 14 | 0 | 11 | 0 | 25 | 17 |
| 58. | *Sida acuta* | Common Wireweed | Herb | Malvaceae | Broom and medicine | NA | 0 | 11 | 0 | 9 | 20 | 27 |
| 59. | *Sida garckeana* | Wireweed | Herb | Malvaceae | Medicinal, Fodder, Chewing stick | NA | 29 | 0 | 17 | 0 | 46 | 46 |
| 60. | *Sterculia oblonga* | Yellow Sterculia | Tree | Malvaceae | Bark is used for local rope, firewood, timber and medicine | VU | 3 | 0 | 0 | 1 | 4 | 15 |
| 61 | *Triumpheta semitriloba* | Bur Weed | Herb | Malvaceae | Medicinal | NA | 14 | 0 | 0 | 0 | 14 | 41 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| . | | | | | | | | | | | | |
| 62. | *Azadirachta indica* | Neem | Tree | Meliaceae | Medicine, timber, construction, and fuelwood | LC | 1 | 1 | 8 | 1 | 11 | 24 |
| 63. | *Albizia feruginia* | Frywood | Tree | Mimosoideae | Timber, medicine and firewood | NA | 7 | 0 | 5 | 0 | 12 | 12 |
| 64. | *Albizia zygia* | Okuro | Tree | Mimosoideae | Timber, medicine and firewood | LC | 0 | 3 | 0 | 0 | 3 | 16 |
| 65. | *Mimosa pigra* | Giant Sensitive Plant | Herb | Mimosoideae | Medicine and landscape management | LC | 36 | 27 | 18 | 0 | 81 | 74 |
| 66. | *Mimosa pudica* | Sensitive Plant | Herb | Mimosoideae | Medicinal | LC | 0 | 18 | 32 | 0 | 50 | 18 |
| 67. | *Ficus exasperata* | Forest Sandpaper Fig | Shrub | Moraceae | Medicine, firewood, medicine | LC | 0 | 3 | 0 | 0 | 3 | 21 |
| 68. | *Ficus polita* | Heart-leaved fig | Shrub | Moraceae | Medicinal | LC | 3 | 0 | 0 | 7 | 10 | 16 |
| 69. | *Musa paradisiaca* | Plantain | Tree | Musaceae | Food and medicine | NA | 0 | 5 | 0 | 1 | 6 | 16 |
| 70 | *Musa sapientum* | Banana | Tree | Musaceae | Food and medicine | NA | 7 | 0 | 3 | 0 | 10 | 32 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| . | | | | | | | | | | | | |
| 71. | *Psidium guajava* | Guava | Tree | Myrtaceae | Medicine, fruits and firewood | LC | 0 | 4 | 0 | 3 | 7 | 18 |
| 72. | *Ludwigia decurrens* | Creeping Primrose-willow | Herb | Onagraceae | Medicinal and local water clean up | NA | 11 | 0 | 0 | 2 | 13 | 27 |
| 73. | *Baphia nitida* | Camwood | Shrub | Papilionoideae | Firewood, medicine, trap making, boundary and shrines | LC | 0 | 9 | 2 | 0 | 11 | 17 |
| 74. | *Pterocarpus santalinoides* | Pterocarpus | Tree | Papilionoideae | Vegetable, timber and firewood | LC | 15 | 7 | 16 | 16 | 54 | 23 |
| 75. | *Margaritaria discoidea* | Pheasant-berry | Tree | Phyllanthaceae | Medicine, timber, construction and fuelwood | LC | 0 | 7 | 1 | 3 | 11 | 16 |
| 76. | *Securinega virosa* | White Berry Bush | Shrub | Phyllanthaceae | Ornamental and medicine | NA | 0 | 34 | 22 | 79 | 135 | 154 |
| 77. | *Scoparia dulcis* | Scoparia-weed | Herb | Plantaginaceae | Medicinal | NA | 13 | 0 | 16 | 0 | 29 | 46 |
| 78. | *Axonopus compresus* | Carpet Grass | Creeper | Poaceae | Fodder, Medicinal | NA | 0 | 32 | 0 | 0 | 32 | 86 |
| 7 | *Bambusa* | Common | Tre | Poacea | Construction, boundary, trap | NA | 82 | 74 | 67 | 47 | 270 | 267 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| 9. | *vulgaris* | Bamboo | e | e | making, fodder | | | | | | | |
| 80. | *Digitaria longiflora* | False Couch Grass | Creeper | Poaceae | Fodder and landscape stabilization | NA | 0 | 7 | 16 | 0 | 23 | 43 |
| 81. | *Panicum maximum* | Guinea Grass | Herb | Poaceae | Fodder | NA | 0 | 33 | 0 | 0 | 33 | 78 |
| 82. | *Saccharum officinarum* | Sugarcane | Herb | Poaceae | Food, fodder and medicine | NA | 0 | 83 | 36 | 58 | 177 | 187 |
| 83. | *Setaria megaphylla* | Ribbon Grass | Herb | Poaceae | Fodder | NA | 14 | 11 | 0 | 0 | 25 | 56 |
| 84. | *Zea mays* | Maize | Herb | Poaceae | Food and energy | LC | 0 | 86 | 74 | 34 | 194 | |
| 85. | *Allophylus africanus* | African False Currant | Shrub | Sapindaceae | Medicinal and firewood | LC | 16 | 6 | 11 | 8 | 41 | 43 |
| 86. | *Smilax anceps* | West African sarsaparilla | Climber | Smilacaceae | Medicinal | NA | 4 | 0 | 7 | 0 | 11 | 34 |
| 87. | *Physalis angulata* | Angular Winter Cherry | Herb | Solanaceae | Ripe fruits are eaten for the treatment of kidney stone | LC | 0 | 6 | 13 | 0 | 19 | 18 |

| S/N | Botanical Name | Common Name | Stem Habit | Family | Indigenous Uses / Ethnobotany | IUCN Conservation Status | Study Area | | | | | Control Area / Total Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 |
| 88. | *Musanga cecropioides* | Umbrella Tree | Tree | Urticaceae | Medicine | LC | 9 | 0 | 0 | 7 | 16 | 34 |
| 89. | *Stachytarpheta indica* | Blue Snake Weed | Herb | Verbanaceae | Medicinal | LC | 0 | 4 | 0 | 6 | 10 | 14 |
| 90. | *Cissus species* | Common Cissus | Climber | Vitaceae | Medicinal | NA | 15 | 0 | 3 | 0 | 18 | 33 |
| | **TOTAL ABUNDANCE PER SAMPLING POINT** | | | | | | **1310** | **1596** | **1421** | **1649** | **5976** | **5321** |

**Key: IUCN=International Union for Conservation of Nature; VG=Vegetation; NA=Not Assessed; LC=Least Concern; DD=Data Deficient; and VU=Vulnerable.**

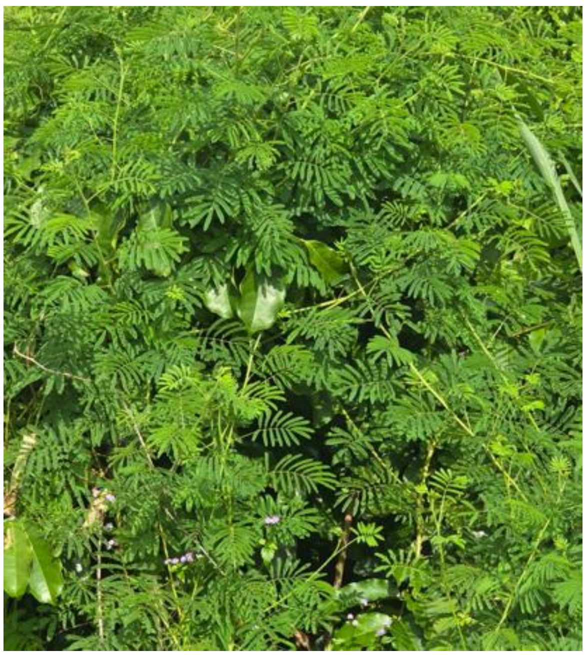
*Ipomoea batatas* (Sweet Potato)

*Arachis hypogaea* (Groundnut)

*Chromolaena odorata* (Siam Weed)

*Mimosa pigra* (Giant Sensitive Plant)

*Lonchocarpus sericeus* (Lilac Tree) *Bambusa vulgaris* (Common Bamboo)

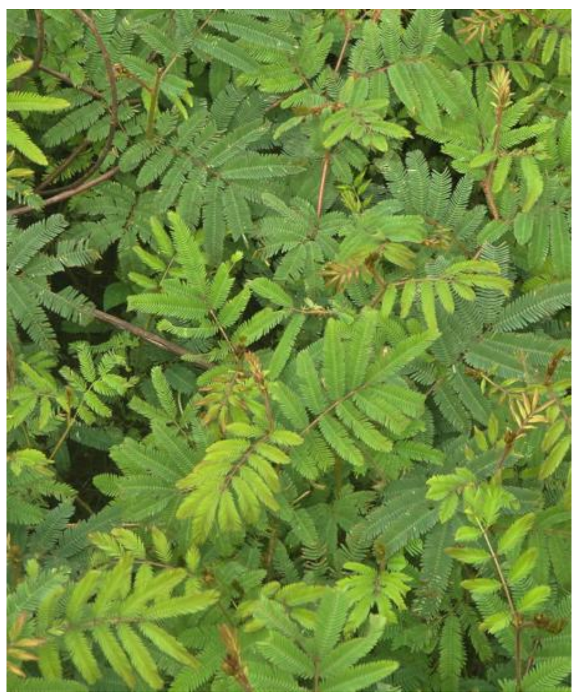


*Mimosa pigra* (Giant Sensitive Plant) *Mimosa pudica* (Sensitive Plant)

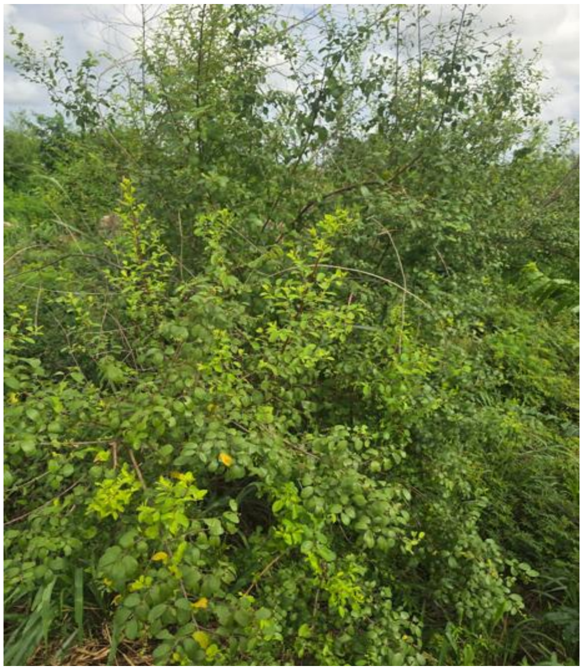
*Bambusa vulgaris* (Common Bamboo)

*Combretum racemosum* (Bushwillows)

*Securinega virosa* (White Berry Bush)



*Mimosa pudica* (Sensitive Plant)



*Securinega virosa* (White Berry Bush) *Ficus exasperata* (Forest Sandpaper Fig)

*Ficus exasperata* (Forest Sandpaper Fig) *Millettia aboensis* (Aboens Millettia)

*Millettia aboensis* (Aboens Millettia)

*Millettia aboensis* (Aboens Millettia)

*Panicum maximum* (Guinea Grass)

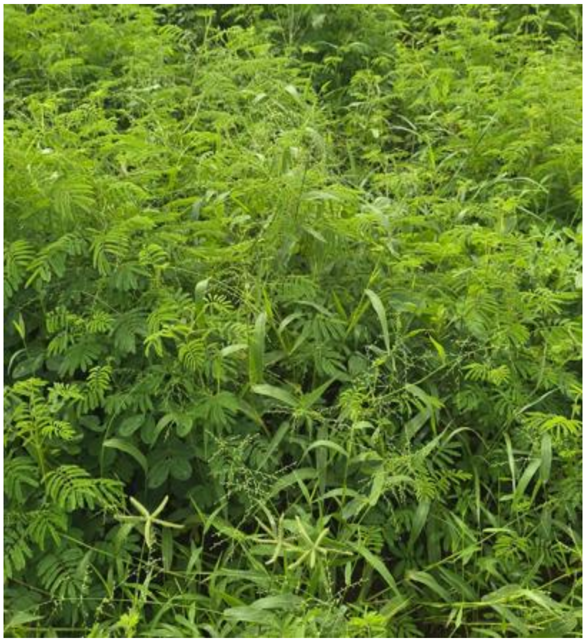
*Mimosa pigra* (Giant Sensitive Plant)

*Panicum maximum* (Guinea Grass)

*Tithonia diversifolia* (Tree Marigold)

*Panicum maximum* (Guinea Grass)

*Securinega virosa* (White Berry Bush)



*Mimosa pigra* (Giant Sensitive Plant) *Abelmoschus esculentus* (Okra)

*Manihot esculenta* (Cassava) *Elaeis guineensis* (African Oil Palm)

*Glyphaea brevis* (Monach)

*Manihot esculenta* (Cassava)

*Albizia adianthifolia* (Flat-crown)

*Mimosa pigra* (Giant Sensitive Plant)

**Plate 4.8: Pictures showing some flora species sampled around the project area.**

### 4.8.2 Wildlife Assessment

The wildlife inventory for the study area was carried out by examining the animal footprints, droppings, interview with local hunters, etc. During the cause of the fieldwork campaign, birds and some other reptiles were observed and identified. Also, the local markets were visited to see and identify the predominant wildlife species. Wildlife species play crucial roles in plant pollination and reproduction, seeds dispersal, maintenance of ecological balance, while serving as sources of traditional medicine in addition to food / protein sources for the local residents within the project area. Inventory of wildlife species was carried out in the project area using a combination of two (2) techniques or methods involving physically spotting fauna species, (direct field observations) and indirect method of species existence (carcasses, nesting grounds, footprints, vocalization, burrows, feathers, dung and feeding activities). There were interactions with indigenous people in the project area through Focus Group Discussion (FGD). The wildlife species of the area comprises of mammals, aves, herpetofauna (reptiles and amphibians) and some invertebrate fauna species (insects, mollusks and arachnids).

Going forward, a total of seventy-three (73) fauna species in fifty-one (51) zoological families were sampled for the proposed EIA project.

Breakdown presents eleven (11, 15.07%) mammalian species recorded for the study, avian species recorded thirty (30, 41.09%) species around the project area. Reptiles recorded five (5, 6.85%) species for the study as amphibians, recorded two (2, 2.74%) species for the study. Furthermore, insects recorded eighteen (18, 24.66%) species in the project area. Mollusks, recorded four (4, 5.48%) species while three (3, 4.11%) arachnid species were recorded for the proposed ESMP study. Detailed results were presented in **Figure 4.15**.

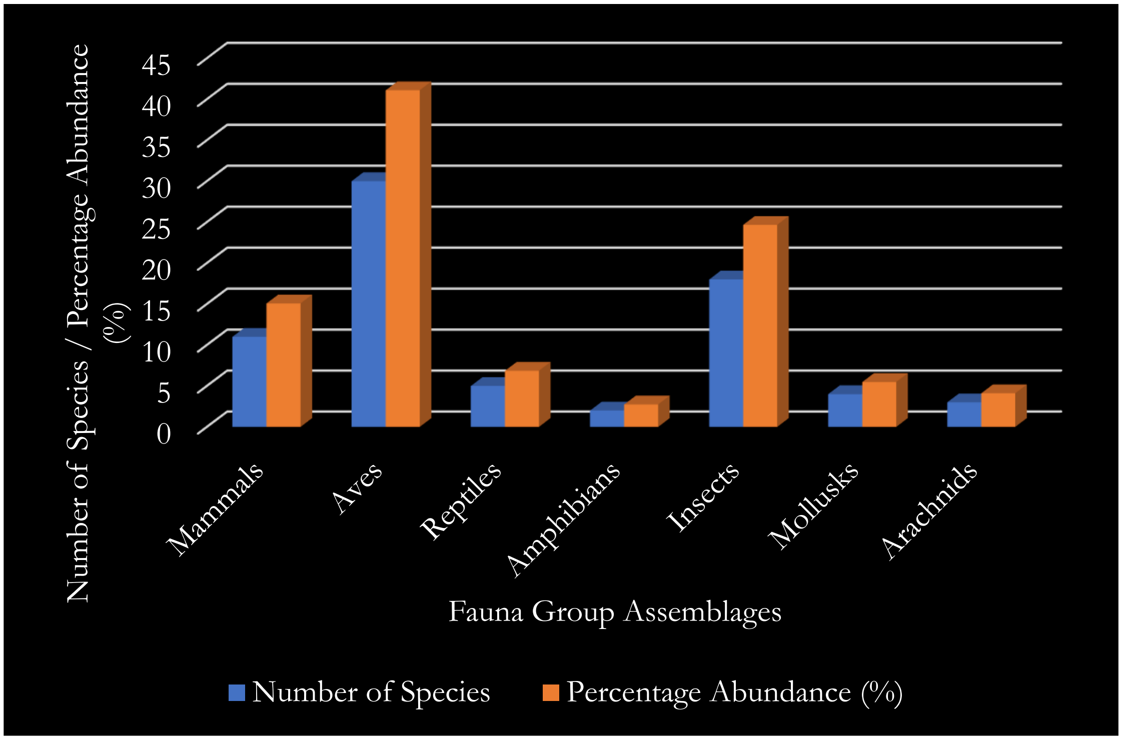



**Figure 4.15: Graphical illustration of fauna species richness in the study area.**

The result revealed that avian species recorded the highest species richness and percentage abundance, followed by insects, mammals, reptiles, mollusks, amphibians as arachnids recorded the least. The presence of some avian and insect taxa in the project area implies good number of plant pollinators with possible ecosystem health implications. Examples of such avian species includes, *Cinnyris coccinigastrus* (Splendid Sunbird) and *Cinnyris lotenius* (Loten's Sunbird). Most of the insect species are also plant pollinators with beneficial health implications on the ecosystem.

**Mammals**

These species were sampled through a combination of methods involving direct sampling in the field as well as indirect evidence with the local residents in the project area. Mammals play important roles in the ecosystems by providing essential services such as seed dispersal, and plant pollination, as well as regulating insect populations attacking agricultural farmlands thereby reducing disease transmission across any ecosystem. These species act as indicators o143elieve143al ecosystem health according to some authors (Jones and Safi, 2011). Mammals are generally attracted by thick vegetation cover and serene environment. The low diversity of mammals in the study area is indicative of a habitat altered through anthropogenic activities in addition to pressure poaching.

**Aves**

Birds help in maintaining sustainable population levels of their prey and predator species. After death, these species provide food for scavengers and decomposers. Many birds are important in plant reproduction through their services as pollinators for example: *Cinnyris lotenius* (Loten's Sunbird) and *Cinnyris coccinigastrus* (Splendid Sunbird) or seed disperser's example: *Lophoceros fasciatus* (Congo Pied Hornbill) and *Bycanistes fistulator* (Western Piping Hornbill). Some birds are considered keystone species as their presence in an area or disappearance from such ecosystem affects other species indirectly which may be detrimental to fauna community.

**Species richness**

Avian species were the most diverse around the project area as species ability to fly presents some levels of visibility enabling them to easily be sampled (**Figure 4.15**). This great diversity over other fauna group may be attributed to availability of suitable breeding grounds within the project area. Meanwhile most species have also adapted build-up area for nesting/breeding, in addition to availability of food sources and reduced ecological threat compared to other fauna groups.

**Migratory Avian Species**

Some avian species are known to migrate from place to place. Avian migration is either a regular or irregular seasonal movement between the North and South geographic regions. In some species, the movement is one directional. Avian migration is usually driven primarily by food search, habitat destruction / alteration influenced by anthropogenic perturbation, escape from pollution and changes in weather conditions, etc. These movements are usually initiated for breeding and overwintering ground purposes according to Veen *et al*. (2014).

In Nigeria, like other African countries, migratory birds commence this movement between late April to July moving to warmer areas and return between September / October to winter grounds around the Southern parts of Nigeria. Migratory movement often results in high mortality and predation. The migratory species of the project area includes: *Bubulcus ibis* (Cattle Egret), *Milvu145elievens* (Black Kite), and *Eurystomus glaucurus* (Broad-billed Roller).

Meanwhile, *Milvus migrans* (Black Kite) is regarded as "migratory and raptor species" whereas their presence around any study area signals dry or transition season while disappearance within an area implies wet season. Their migration commences late April to the month of July to overwinter around the Northern hemisphere due to heavy rainfall that occurs around the South in the said period, as species return early September having overwintered in the Northern hemisphere in agreement with the findings of Veen *et al.,* (2014). All the sampled migratory avian fauna species of the study area are all intra African migrants moving through the Northern and Southern hemisphere depending on the prevalent climatic condition / season, either to overwinter or for breeding reasons.

*Milvus migrans* (Black Kite)

*Bubulcus ibis* (Cattle Egret)

**Plate 4.9: Pictorial evidence of some migratory avian species sighted around the study area.**

**Raptors of the study area (Birds of prey)**

The number of diurnal and nocturnal predatory birds that hunt and feed on rodents, insects and small organisms exerts strong biodiversity influence on the ecosystem (Fowler *et al.*, 2009). I145eliech environment, they act as keystone species by regulating their prey population and abundance. Some are known a' 'Earth cleaners; for their role in eating up carcasses or dead organisms.  Raptors are members of Accipritidae, Pandionidae, Sagittaridae, Falconidae and

Cathartidae, belonging to Acciptriformes order of birds of prey (Fowler *et al*., 2009). The raptor species sampled around the project area include: *Accipiter ovampensis* (Ovambo Sparrowhawk), *Milvus migrans* (Black Kite), and *Polyboroides radiatus* (Madagascan Harrier-hawk).

**Threatened species of the project area**

The conservation status of the reported species was documented using the IUCN 2025 version-2 criterion of the Threatened species Red List as a guide. There was no threatened fauna species of conservation interest that was reported for the study. The management of threatened species around any project area is enshrined in the IFC GN6 as well as other relevant literatures to ensure sustainability (IFC, 2019; 2012).

**Herpetofauna**

These species include group of organisms with great ecological importance for their role in responding rapidly to ecological perturbation making them important in monitoring environmental pollution as these species are very sensitive to gaseous or liquid pollutants. Their presence o146elievece in any environment may imply pristine or polluted environment. As such, breeding ground for these species is highly advocated.

Among the herpetofauna, there was no species of conservation interest. However, conservation of breeding grounds should be encouraged since these species play important roles in ecosystem balancing and moderation.

**Invertebrate fauna**

Invertebrate fauna plays key roles in plant pollination which in turn aids in maintaining soil quality and fertility. These species are preyed upon by other fauna groups making global food chain and food web progressive. Three subgroups of invertebrates studied for the project includes: insects, mollusks and arachnids. The presence of some insect species in the project area indicates availability of plant pollinators, and prey for some fauna groups around the project area. However, insects and many other invertebrates are highly sensitive to gaseous pollutants, suggesting the need for proper Environmental Management Plan (EMP) around the project area, including appropriate containment of gaseous and liquid pollutants in the case of accidental discharge.

**Species Abundance Analysis**

The analysis of the project area revealed that the highest number of fauna individuals per sampling point was recorded in VG.C1 with 1298 individuals. This was followed by VG.4 with 613 fauna individuals, VG.2 with 457 individuals, VG.1 with 352 individuals while VG.3 the least recorded 289 individuals in decreasing order of individual abundance. The checklist indicates that the project area is full of fauna species that were not threatened by their conservation status.

**Table 4.10: Comprehensive checklist of the fauna species sampled in the proposed EIA project area.**

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| | **MAMMALS** | | | | | | | | | | | | | |
| 1. | *Atherurus africanus* | African Brush-tailed Porcupine | Hystricidae | LC | √ | | | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 2. | *Cercopithecus mona* | Mona Monkey | Cercopithecidae | NT | √ | | √ | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 3. | *Civettictis civetta* | African Civet | Viverridae | LC | √ | √ | | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 4. | *Cricetomys gambianus* | Gambian Pouched Rat | Nesomyidae | LC | √ | | √ | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 5. | *Funisciurus anerythrus* | Thom's's Rope Squirrel | Sciuridae | LC | | | √ | √ | 1 | 0 | 1 | 0 | 2 | 3 |
| 6. | *Herpestes species* | Mongoose | Herpestidae | NA | √ | √ | | | 0 | 0 | 0 | 0 | 0 | 0 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG.1 | VG.2 | VG.3 | VG.4 | Total Abundance | VG.C1 / Total Abundance |
| 7. | *Philantomba monticola* | Blue Duiker | Bovidae | LC | √ | √ | | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 8. | *Protoxerus stangeri* | African Giant Squirrel | Sciuridae | NA | √ | | √ | | 2 | 1 | 1 | 1 | 5 | 4 |
| 9. | *Thryonomys swinderianus* | Great Cane Rat | Thryonomyidae | LC | √ | | | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 10. | *Tragelaphus scriptus* | Bushbuck | Bovidae | LC | √ | | | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 11. | *Xerus erythropus* | Striped Ground Squirrel | Sciuridae | LC | √ | | | √ | 0 | 0 | 0 | 1 | 1 | 0 |
| | **AVES** | | | | | | | | | | | | | |
| 12. | *Anthus* | African Pipit | Motacillidae | LC | | √ | | √ | 3 | 2 | 2 | 7 | 14 | 15 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| | *cinnamomeus* | | | | | | | | | | | | | |
| 13. | *Chrysococcyx klaas* | Klaas's Cuckoo | Cuculidae | LC | | √ | | √ | 2 | 7 | 11 | 0 | 20 | 11 |
| 14. | *Accipiter ovampensis* | Ovambo Sparrowhawk | Accipitridae | LC | | √ | | √ | 4 | 0 | 1 | 3 | 8 | 7 |
| 15. | *Apus affinis* | Little Swift | Apodidae | LC | | √ | √ | √ | 22 | 12 | 6 | 2 | 42 | 47 |
| 16. | *Bubulcus ibis* | Cattle Egret | Ardeidae | LC | | √ | | √ | 15 | 6 | 15 | 4 | 40 | 25 |
| 17. | *Bycanistes fistulator* | Western Piping Hornbill | Bucerotidae | LC | √ | √ | | | 3 | 0 | 2 | 1 | 6 | 5 |
| 18. | *Centropus senegalensis* | Senegal Coucal | Cuculidae | LC | √ | √ | | √ | 1 | 1 | 0 | 1 | 3 | 4 |
| 19. | *Cinnyris coccinigastrus* | Splendid Sunbird | Nectariniidae | LC | | | √ | √ | 3 | 3 | 1 | 3 | 10 | 8 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| 20. | *Cinnyris lotenius* | Loten's Sunbird | Nectariniidae | LC | | | √ | √ | 0 | 1 | 5 | 1 | 7 | 7 |
| 21. | *Corvus albus* | Pied Crow | Corvidae | LC | √ | √ | | √ | 16 | 24 | 11 | 34 | 85 | 65 |
| 22. | *Cypsiurus parvus* | African palm swift | Apodidae | LC | | √ | | √ | 5 | 5 | 0 | 1 | 11 | 12 |
| 23. | *Eurystomus glaucurus* | Broad-billed Roller | Coraciidae | LC | | √ | | √ | 3 | 0 | 0 | 2 | 5 | 3 |
| 24. | *Halcyon senegalensis* | Woodland Kingfisher | Alcedinidae | NA | | √ | | √ | 0 | 0 | 2 | 0 | 2 | 2 |
| 25. | *Lophoceros fasciatus* | Congo Pied Hornbill | Bucerotidae | LC | √ | √ | | √ | 3 | 1 | 1 | 4 | 9 | 6 |
| 26. | *Merops species* | Bee-eater | Meropidae | LC | | √ | | √ | 0 | 0 | 4 | 2 | 6 | 4 |
| 27. | *Milvus migrans* | Black Kite | Accipitridae | LC | √ | √ | | √ | 15 | 22 | 18 | 32 | 87 | 78 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| 28. | *Numida meleagris* | Guineafowl | Numididae | NA | √ | | | √ | 0 | 0 | 0 | 1 | 1 | 1 |
| 29. | *Nigrita canicapillus* | Grey-headed Nigrita | Estrildidae | LC | √ | √ | | | 1 | 1 | 3 | 1 | 6 | 4 |
| 30. | *Passer domesticus* | House Sparrow | Passeridae | LC | √ | √ | | √ | 4 | 7 | 4 | 6 | 21 | 18 |
| 31. | *Ploceus cucullatus* | Village Weaver | Ploceidae | LC | √ | √ | | √ | 11 | 16 | 8 | 4 | 39 | 32 |
| 32. | *Ploceus nigerrimus* | Vieill’t's Black Weaver | Ploceidae | LC | √ | √ | | √ | 32 | 21 | | 18 | 71 | 23 |
| 33. | *Polyboroides radiatus* | Madagascan Harrier-hawk | Accipitridae | LC | √ | √ | | √ | 4 | 4 | 2 | 2 | 12 | 9 |
| 34. | *Pternistis squamatus* | Scaly Francolin | Phasianidae | LC | √ | √ | | √ | 0 | 0 | 0 | 1 | 1 | 1 |
| 35. | *Pycnonotus* | Common | Pycnonotidae | LC | √ | √ | √ | | 6 | 4 | 12 | 11 | 33 | 21 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| | *barbatus* | Bulbul | | | | | | | | | | | | |
| 36. | *Spermestes bicolor* | Black and White Mannikin | Estrildidae | LC | √ | | | | 8 | 2 | 7 | 0 | 17 | 16 |
| 37. | *Spilopelia senegalensis* | Laughing Dove | Columbidae | LC | √ | | √ | | 2 | 0 | 2 | 5 | 9 | 13 |
| 38. | *Streptopelia capicola* | Ring-necked Dove | Columbidae | LC | √ | | √ | | 0 | 6 | 2 | 7 | 15 | 11 |
| 39. | *Treron calvus* | African Green-pigeon | Columbidae | LC | √ | | √ | | 2 | 2 | 7 | 2 | 13 | 23 |
| 40. | *Vidua macroura* | Pin-tailed Whydah | Viduidae | LC | | √ | | √ | 1 | 1 | | 1 | 3 | 2 |
| 41. | *Vidua nigeriea* | Quailfinch | Viduidae | LC | | √ | | √ | 2 | | 1 | 3 | 6 | 6 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| | | Indigobird | | | | | | | | | | | | |
| | **HERPETOFAUNA** | | | | | | | | | | | | | |
| 42. | *Agama agama* | Common Rainbow Lizard | Agamidae | LC | | √ | | √ | 7 | 11 | 5 | 21 | 44 | 22 |
| 43. | *Amietophrymus maculatus* | Flat Backed Toad | Bufonidae | NA | | √ | | √ | 2 | 2 | 0 | 0 | 4 | 3 |
| 44. | *Python regius* | Ball Python, Royal Python | Pythonidae | NT | √ | √ | | √ | 0 | 0 | 0 | 0 | 0 | 0 |
| 45. | *Dispholidus typus* | Boomslang | Colubridae | NA | | √ | | √ | 1 | 0 | 1 | 0 | 2 | 2 |
| 46. | *Trachylepis striata* | African Striped Skink | Scincidae | LC | | √ | √ | | 7 | 11 | 6 | 3 | 27 | 21 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| 47. | *Naja nigricollis* | Forest Cobra | Elapidae | LC | √ | √ | | √ | 0 | 0 | 1 | 0 | 1 | 1 |
| 48. | *Ptychadena mascareniensis* | Mascarene Grass Frog | Ptychadenidae | LC | √ | √ | | | 11 | 4 | 0 | 2 | 17 | 15 |
| | **INVERTEBRATE FAUNA** | | | | | | | | | | | | | |
| 49. | *Acanthacris species* | Garden Locust | Acrididae | LC | | | √ | | 11 | 6 | 5 | 6 | 28 | 15 |
| 50. | *Achatina fulica* | Giant African Land Snail | Achatinidae | NA | √ | | √ | √ | 2 | 1 | 3 | 7 | 13 | 10 |
| 51. | *Achatina marginata* | Giant African snail | Achatinidae | NA | √ | | √ | √ | 4 | 0 | 3 | 0 | 7 | 6 |
| 52. | *Apis species* | Bees | Apidae | NA | √ | | √ | √ | 14 | 11 | 8 | 32 | 65 | 43 |
| 53. | *Badumna insignis* | Common Black | Desidae | NA | | √ | √ | | 1 | 1 | 2 | 1 | 5 | 4 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| | | Spider | | | | | | | | | | | | |
| 54. | *Gryllus species* | Cricket | Gryllidae | NA | √ | | √ | | 0 | 1 | 1 | 6 | 8 | 4 |
| 55. | *Junonia oenone* | Dark Blue Pansy | Nymphalidae | LC | | | √ | | 12 | 8 | 15 | 11 | 46 | 18 |
| 56. | *Limicolaria aurora* | Garden Snail | Achatinidae | NA | √ | | √ | | 14 | 3 | 11 | 23 | 51 | 18 |
| 57. | *Dorylus molestus* | Driver Ants | Formicidae | NA | | √ | √ | | 0 | 136 | 0 | 221 | 357 | 388 |
| 58. | *Archispirostreptus gigas* | Giant African Millipede | Spirostreptidae | NA | √ | | √ | √ | 12 | 7 | 27 | 2 | 48 | 28 |
| 59. | *Limicolaria martensiana* | Garden Snail | Achatinidae | NA | √ | | √ | | 0 | 21 | 5 | 11 | 37 | 26 |
| 60. | *Loxosceles reclusa* | Brown Recluse Spider | Sicariidae | NA | | √ | √ | | 1 | 1 | 0 | 3 | 5 | 5 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| 61. | *Lucilia sericata* | Common Green Bottle Fly | Calliphoridae | NA | | | √ | | 4 | 6 | 2 | 11 | 23 | 17 |
| 62. | *Macromia trifasciata* | Dragon Fly | Macromiidae | LC | | √ | √ | | 15 | 12 | 7 | 4 | 38 | 8 |
| 63. | *Mantis religiosa* | Praying Mantis | Mantidae | LC | √ | √ | √ | | 7 | 5 | 3 | 1 | 16 | 16 |
| 64. | *Microcentrum rhombifolium* | Greater Angle-wing Katydid | Tettigoniidae | NA | √ | | √ | | 2 | 3 | 2 | 12 | 19 | 7 |
| 65. | *Oecophylla longinoda* | Tailor Ant | Formicidae | NA | | | √ | | 35 | 18 | 32 | 42 | 127 | 57 |
| 66. | *Papilio machaon* | Old World Swallowtail | Papilionidae | LC | | | √ | | 4 | 11 | 5 | 1 | 21 | 18 |
| 67. | *Pseudochorthippus* | Grasshopper | Acrididae | NA | √ | | √ | | 0 | 3 | 3 | 5 | 11 | 11 |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| | *species* | | | | | | | | | | | | | |
| 68. | *Sarcophaga crassipalpis* | Flesh Fly | Sarcophagidae | NA | | | √ | | 3 | 13 | 5 | 7 | 28 | 13 |
| 69. | *Scapsipedus species* | Common Edible Cricket | Gryllidae | NA | √ | | √ | | 2 | 2 | 1 | 2 | 7 | 4 |
| 70. | *Tettigonia species* | Great Green Bush-cricket | Tettigoniidae | LC | √ | | √ | | 1 | 2 | 1 | 2 | 6 | 5 |
| 71. | *Vanessa species* | Red Admiral | Nymphalidae | NA | | | √ | | 7 | 4 | 2 | 1 | 14 | 12 |
| 72. | *Vespula vulgaris* | Common Wasp | Vespidae | NA | | √ | √ | | 2 | 4 | 0 | 0 | 6 | 8 |
| 73. | *Zonocerus variegatus* | Variegated Grasshopper | Pyrgomorphidae | NA | | | √ | | 0 | 1 | 4 | 15 | 20 | 7 |
| | | | | | | | | | **352** | **457** | **289** | **613** | **1711** | **1298** |

| S/N | Zoological Name | English/Common Name | Family Name | IUCN Conservation Status | Ecosystem Services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PS | RS | SS | CS | VG. 1 | VG. 2 | VG. 3 | VG. 4 | Total Abundance | VG.C1 / Total Abundance |
| **TOTAL ABUNDANCE PER SAMPLING POINT** | | | | | | | | | | | | | | |

**Key: IUCN=International Union for Conservation of Nature; PS=Provisional Service; SS=Supportive Service; RS=Regulatory Service; CS=Cultural Service; VG=Vegetation; NA=Not Assessed; LC=Least Concern, and NT=Near Threatened.**

***Milvus migrans* (Black Kite)** **Corvus albus* (Pied Crow)**

***Polyboroides typus* (African Harrier Hawk)** ***Ploceus cucullatus* (Village Weaver)**

***Spermestes bicolor* (Black and White Mannikin)** ***Acanthacris species* (Garden Locust)**

***Corvus albus* (Pied Crow)** ***Polyboroides radiatus* (Madagascan Harrier-hawk)**

***Papilio machaon*** **(Old World Swallowtail)** ***Agama agama*** **(Common Rainbow Lizard)**

***Pycnonotus barbatus*** **(Common Bulbul)** ***Polyboroides radiatus*** **(Madagascan Harrier-hawk)**

**Plate 4.10: Pictures showing some of the fauna species sampled around the project area.**

## 4.9 Land Use/Cover

Land is one of the most valuable natural resources within Ibusa, Oshimili North Local Government Area of Delta State, serving as the foundation for residential development, agriculture, transportation, commercial enterprises and industrial activities. Historically, land use within the stakeholder communities has been predominantly agricultural, with crop cultivation and related farming activities constituting the principal livelihood of the local population. However, the rapid expansion of Asaba and neighbouring settlements over recent decades has accelerated urbanization within Ibusa, resulting in progressive changes in land use from predominantly rural and agricultural landscapes to a heterogeneous mix of residential, commercial, institutional and light industrial developments. This transition reflects the growing economic importance of the area and its increasing integration into the Asaba metropolitan corridor.

The proposed Rainoil Limited/Rainoil Gas Limited Mini 500 MT Liquefied Petroleum Gas (LPG) Blending Plant is strategically located within an area that exhibits an established mixed land-use pattern, making the site generally compatible with the proposed industrial development. Field reconnaissance conducted during the baseline study revealed that the immediate surroundings of the proposed facility comprise an abandoned Chinese manufacturing facility located beside to the proposed project site, also, an existing block-making industry situated between the project perimeter fence and the expressway, and another block industry adjoining the site. The occurrence of these industrial establishments indicates that the area has already experienced substantial anthropogenic modification and demonstrates an existing industrial character that is consistent with the proposed LPG blending operations.

Apart from industrial activities, agricultural land use remains evident within the wider project area. Cultivated farmlands supporting seasonal food crop production were observed during the field survey, reflecting the continued importance of agriculture as a supplementary economic activity within the host community. In addition, nomadic cattle grazing was observed on available open lands surrounding the proposed site, indicating that sections of the landscape continue to function as temporary grazing areas and livestock movement corridors. These multiple land-use activities illustrate the characteristic peri-urban nature of Ibusa, where agriculture, commerce, transportation and light industrial developments coexist within the same geographical setting. The resulting landscape can therefore be classified as a mixed-use environment comprising industrial facilities, agricultural lands, transportation infrastructure and open spaces.

The location of the proposed facility adjacent to a major expressway provides considerable logistical and operational advantages for the transportation of construction materials, LPG products and operational equipment while reducing the need for additional road construction or significant modification of the existing transportation network. Furthermore, the proposed development will occupy a previously disturbed site that has already been influenced by past industrial activities. Consequently, the project is expected to require minimal vegetation clearance and limited conversion of productive agricultural land, thereby reducing potential impacts on terrestrial habitats, ecosystem functions and existing land-use practices.

From an Environmental and Social Management Plan (ESMP) perspective, the proposed LPG blending facility is considered compatible with the prevailing land-use pattern because it complements the existing industrial and commercial developments already established within the project vicinity. Nevertheless, appropriate environmental management measures should be implemented throughout the construction and operational phases to ensure that adjoining agricultural activities, neighbouring industries and transportation infrastructure are not adversely affected. Such measures should include effective dust suppression, noise control, stormwater drainage management, traffic management, erosion prevention, proper waste handling, landscape restoration of disturbed areas and continuous stakeholder engagement to minimise potential land-use conflicts and maintain harmonious coexistence with surrounding land users.

Human use of land resources gives rise to “land use” which varies with the purpose it serves, whether they be food production, provision of shelter, recreation, extraction and processing of materials and so on, as well as the bio-physical characteristics of land itself. The land use of the project area is summarized in **Table 4.11** and **Table 4.12**.

**Table 4.11: Checklist of the land uses around the project area**

| S/N | Land Cover | Land Use |
|---|---|---|
| 1 | Built-up area | Residential, Commercial, Institutional/ Public (Schools, meeting halls, Churches, markets and clinics etc) |
| 2 | Agriculture | Subsistence farming (small holder Rain fed agriculture) |
| 3 | Forest | Freshwater swamp forest |
| 4 | Water Body | River, stream and pounds |

**Table 4.12: Land use Analysis**

| Land Use | Percentage (%) |
|---|---|
| Built-up Area | 18 |
| Freshwater swamp forest | 29 |
| Subsistence cropping/ farming (small holder Rain fed Agriculture) | 30 |
| Natural Water Bodies e.g. River, stream. Ponds etc. | 24 |
| TOTAL | 100 |

Analysis of the land use around the project area reveals that agricultural land use dominated the project area, which may be linked to the increase in human population and subsequent food demand for survival leading to intense pressure on forest community. This was followed by freshwater forest habitat whereas, build up area recorded the least (**Table 4.24**).

## 4.10 Socio –Economic Studies

### 4.10.1 Background Information

The project proponent, Rainoil Limited proposes to embark on the establishment of a Mini 500MT LPG Blending Plant project in Ibusa, Oshimili North LGA of Delta State, Nigeria. The Proponent, therefore, initiated this study as a pre-requisite for obtaining the necessary permits to establish, construct and operate the proposed project in accordance the applicable legal requirements. The Proponent also recognizes the importance of comprehensive Environmental and Social Management Plan (ESMP) to the success of any developmental project and is committed to the necessary studies to understand the environmental system of its planned project on the subject site and environs, in order to address areas where significant environmental impacts may be identified.

In compliance with the Nigerian’s environmental and social regulatory requirements (FMEnv EIA Act No. 86 of 1992 and EGASPIN, 2018 (now NMDPRA) and RAINOIL LIMITED/RAINOIL GAS LIMITED’s corporate HSE Policies and international best practice/requirements (World Bank EIA Guidelines, 1991, WB/IFC ESIA, 2012), the Proponent commissioned a competent and independent consulting company in the name of Masterplan Environmental Services Consult to carry out the Environmental and Social Management Plan study for the 500MT LPG Blending Plant project so as to aid proper project planning. The aspect of this report focuses on human and social environment (socioeconomic). Prescribed and acceptable procedures and methodologies were employed for data collection (socioeconomic) so as to characterize the human environment as well as evaluate impacts of the proposed 500MT LPG Blending Plant on proximate populations of the area.

### 4.10.2 Scope of Work for Socio-economic

Project influences and receptor exposure are felt by the human population. Consequently, data requirement, generic in nature were detailed in the terms of reference (ToR) to include but not limited to the following data needs:

**Table 4.13: Socioeconomic Variables**

| | Social Features | Variables |
|---|---|---|
| 1 | Demography | Population size and distribution (age, gender, ethnic groupings, population density, dependency and sex ratio), marital status, educational attainment, primary and secondary school drop-out rates, history and trend of migration, net enrolment ratios for primary and secondary schools, etc. |
| 2 | Livelihood | Income distribution and consumption patterns, employment status, occupation, occupational mobility and adjustment, poverty profile, land use and tenure system, and other economic activities. |
| 3 | Social Infrastructure | Major means of transportation; educational institutions, water supply, electricity, communication, recreational facilities, waste management facilities, housing (type, pattern and quality) etc. |
| 4 | Cultural Properties | Value system, social norms, location and spatial distribution of historical sites, archaeological artefacts, shrines, sacred forests/scenic areas; religion, plants/animal species of cultural value, festivals, marriage practices, cultural calendar etc. |
| 5 | Natural Resources and Land Use | Values and use of natural resources including rights over private, rental, common ownership and access to resources – especially with respect to women; local conservation practices (closed seasons/closed locations) etc. |
| 6 | Perception of the project | Perception of associated project risks and impacts on quality of life, rating of relationship with the CLIENT, pleasure/displeasure with proposed project, expectations etc. |
| 7 | The role of women and children | Rights and privileges, contribution to socio-economic development; activity systems and political 167elieve167d167on, women trafficking, child labour etc. |
| 8 | Physically Challenged | Rights and privileges, contribution to socio-economic development; activity systems, social exclusion etc. |
| 9 | Social Structure and Organization | Settlement history, ethnic groups, social organization and traditional governance – power and authority structure; history |

| | Social Features | Variables |
|---|---|---|
| | | of conflicts and their resolution including the role of women |
| 10 | Sex Trade | Population, Frequency, Nature, types, origin, and socio-economic aspects etc. |

### 4.10.3 Study Approach, Data Gathering & Analysis

The socio-economic data gathering involve the use of some techniques like interview schedule, survey question administration, key informant interview and focus group discussion (FGD). These techniques are found to be useful in participatory rural and learning appraisal techniques. The field survey study was carried out across the identified project affected communities and also facilitated by the community's representative who attended the pre-field mobilization meeting/scoping workshop as well as members of the communities who are familiar with data gathering exercise.

In the study both qualitative and quantitative techniques were used for data collection…and as a primary technique of data gathering, community consultation and focus group discussions were used as well as community leaders and other participant. In the process, probing questions on crucial socio-economic issues were raised and answers ask for from the participants in relation to their positions in community and level of knowledge **(*See plate 4.11*)**. Visitations were also carried out on the existing social infrastructural facilities and services, e.g., education and health care for necessary information on education and health.

Meanwhile, random sampling technique was used in selecting respondents from the surveyed communities during the community gathering (focus group discussion) as well as during the cross session of respondent within each community with the adult population as the target. At the end of the focus group discussion (FGD) sessions/community-wide interaction meetings, structured questionnaires were administered to a cross section of each of the community with the aid of the community's leadership and facilitator. As a survey instrument and primary data collection method, the questionnaire was structured such that binary, optional and open-ended questions were asked to solicit the necessary answers to questions from the householder. Fifty (50) questionnaires were administered at the community and out of which thirty-two (32) questionnaires were adequately completed for analysis, giving a response rate of 64% (***Plate 4.11***). Below are some sampled pictures during focus group discussion (FGD) with the stakeholder communities.

**Table 4.14: Focus Group Discussion (FGD) Venue, Questionnaire administered and Retrieved**

| S/no | Community | Focus Group Discussion (FGD) Venue | Questionnaire administered | Questionnaire retrieved |
|---|---|---|---|---|
| 1 | Igbuzor | Town Hall | 50 | 32 |
| | **Total** | | **134** | 32 **(64%)** |

### 4.10.4: Socio-economic Data Analysis and Presentation

In analyzing the primary and secondary data, simple descriptive methods and summary statistics like mean, range, mode and percentage were used. Some of the data were presented in table and graph…and also six key levels of aggregation and analysis were used. These are national, regional, state, local government area, community, household and individual respondent. Meanwhile, the population of the host community was projected using result of the 2006 national census released by the National Population Census (NPC). The linear extrapolation and exponential growth model of population projection method are often used in estimating population. While the linear extrapolation model assumes population growth to occur in constant increment over time, the exponential model assumes rate of population growth as not constant but rather changes with time, growing faster as the population size increases. Put differently, population more often than not grows exponentially rather than linearly. However, the exponential growth model was used in estimating the population of the community. Thus

Exponential Growth Model: $Pn = Po\ (1+r)^n$

Where:

**5.** Population projection using the exponential model

Pn=Po (1 +r) n; Po is population in the base year, r is the estimated annual growth rate of population, and n is time lapse in years.

ii. Sex Ratio = $\frac{\text{Number of males in the LGA} \times 100}{\text{Number of females in the LGA}}$

iii. Dependency Ratio = $\frac{\text{Population} \leq \text{14years + population} \geq \text{65years} \times 100}{\text{Population aged 15-64years}}$

**5.** Crude Birth Rate (CBR) = $\frac{\text{Number of births in the community in one-year} \times 100}{\text{Mid-year population}}$

**5.** Crude Death Rate (CDR) =

$$\frac{\text{Number of deaths in the community in one-year} \times 100}{\text{Mid-year population}}$$

**Plate 4.11: Community-wide meetings and interactions at proposed Rainoil Mini/500MT LPG Blending Plant stakeholders for socioeconomic data collection**

### 4.10.5: Social Profile

Project influences and receptor exposure are felt by the human population. This section of the EIA focuses on the Socio-Economic parameters such as settlement history, population characteristics, educational status, occupation, employment, income, expenditure, land and, water resource ownership, housing, infrastructure, social structure, religion, customs, belief, power and governance, conflicts, conflict resolution and inhabitants' perception of the proposed Rainoil Mini/500MT LPG Blending Plant project.

### 4.10.5.1: Study Communities

The proposed project stakeholder's community is Igbuzor in Oshimili North LGA of Delta State. The community is predominantly inhabited by the Enuani ethnic group of Delta State. Igbuzor (Ibusa) in Delta State is made up of 10 main quarters (Ogbes/kindreds). They are: Umuekea, Umuodafe, Umuidinisagba (Umuisagba), Umueze, Umuehea, Ogbeowele, Anyalaobum (Anyalabum) — including Ezukwu and Achalla-Igbuzo, Umuwagwu, Umuezeagwu and Ogboli. These ten quarters forms the traditional federation commonly referred to as "Igbuzo ebi ili" (Ibusa as one community). They are also grouped traditionally under three major war-chief divisions: Odogwu, Uwolo, and Iyase. Beyond the quarters, Igbuzo (Ibusa) has a very interesting traditional leadership structure and cultural system.

Oshimili North LGA whose Local Government headquarters is in Akwukwuigbo with an area of 509.3km², a Density of 319.1/km² and a population of 118,540 based on the 2006 National Population Census figures, projected at 162,500 in 2022 and current year 2026 projected at 271,983 using 2.0% annual growth rate. However, the in Oshimili North LGA's male-female population ratio in 2006 was 58,101 (49%) and 60,439 (51%).

***Delta State:*** Delta State is one of the nine States created in 1991, excised from the old Bendel State. At its inception, it had nineteen (19) Local Government Areas (LGAs). Delta State as revealed in 2006 census had a population of *4,112,445*, comprises of *2,069,309* males and *2,043,136* females, distributed into about *890,312* households. It also encompasses a landmass or area of over *17,239.24* $km^2$…and this shows an average density of *238.6* persons per $km^2$ (NPC 2006). According to the 2006 census, Delta State, like the nation Nigeria, has witnessed much increase in her population…with a total population of *4,112,445*. Meanwhile, with this population figure, Delta State now ranks the 12th most populous State in the country…and the 2nd most inhabited among the nine (9) oil producing States that comprises the Niger Delta Region. The population is being estimated to be growing at an annual growth rate of 3.2% just as that of the entire country (FGN, Official Gazette, 2007). The population is being estimated to be growing at an annual growth rate of 3.2 just as that of the entire country.

***Nigeria:*** Nigeria, one of Africa's largest countries and its most populous, is located in West Africa. The country covers an area of about 923,768 km2, with an estimated 4,049 km of land boundaries, shared with Cameroon in the east, the Republic of Niger in the north, Chad in the north-east and Benin in the west. In the south, Nigeria's 853-km long coastline opens onto the Atlantic Ocean. The southern lowlands join into the central hills and plateaus, with mountains in the south-east and plains in the north. The country's largest river is the Niger, which joins with the River Benue to form a confluence at Lokoja.

***Niger Delta***: The Niger Delta, situated in the southernmost part of Nigeria and covering an area of about 70,000 km2, is the largest river delta in Africa and the third largest in the world. From a coastal belt of swamps, stretching northwards the land becomes a continuous rainforest which gradually joins with woodland and savanna grasslands in central Nigeria. The swamp, forest and woodland areas occupy about 12 per cent of the delta's land surface. Nigeria gained independence from the United Kingdom in 1960. With a population in excess of 158 million people, Nigeria is a multi-ethnic federation divided into 36 states and the Federal Capital Territory, within which lies the capital city of Abuja. More than 250 ethnolinguistic groups are spread across the country; however, the three dominant groups are the Hausas in the north, the Igbos in the south-east and the Yoruba mainly living in the south-west. Nigeria is rich in natural resources, including natural gas, petroleum, tin, iron ore, coal, limestone, niobium, lead, zinc, timber and extensive arable land. Prior to the discovery of oil in the 1950s, agriculture was the mainstay of the economy, with agricultural produce exported to the more developed parts of the world. By 1971 there had been a shift from agriculture to petroleum production, such that between 1973 and 1981 the value of agricultural exports declined from more than USD 1.5 billion to about USD 0.3 billion. Currently, oil and gas provide 80% of budget revenues and 95% of forex earnings.

### 4.10.6: Political Structure/ Governance

#### 4.10.6.1: Community Power Structure and Governance

The internal structures of a small community living in a single settlement and the structures of the community belonging to a larger community spread out over several hamlets are the same. The men of a community are subdivided into the youth (young men able to work) and the elders, the latter being committed persons who have actively contributed to the development of the community and have to be recommended by other elders or the chiefs/traditional ruler. The women of a community are organized in the same way. Also, there is the young group, married women of working age and the group of the 'elder women. The "elders" (women and men) have a high status in the community. Why? It is because of their experience and often makes the final decisions regarding important activities at the community level. Be that as it may, for over a decade now, many youth groups and movements have hijacked this position due to the perceived inaction of the elders to exploitation.

Even though, a more dynamic indigenous political system based on representative participation and fair sharing of power and responsibilities among the community members and age-grade associations have emerge. Many of the independent villages of the Enuani ethnic group are still being governed on the principles of gerontocracy; executive, legislative and judicial functions are still vested in the hands of the oldest man and his cohorts. As a result, majority, if not all of the Enuni communities, the traditional governance and power structure is organized into hierarchies from the clan level to the individual village/community down to the quarters that constitute each settlement.

Obuzor of Igbuzo: The Obuzor is regarded as the paramount traditional ruler of Igbuzo. The title means the foremost/first person of the community. Senior Diokpa: Traditionally, the Senior Diokpa (oldest recognized lineage head) was the highest authority before the formal Obuzor institution. The Diokpa system according to the people still remains important because Igbo traditional governance is built around age-grade, lineage and ancestral authority.

Ogbes and their leadership: Each Ogbe (quarter) has its own internal leadership led by its Diokpa-Ogbe and council of elders. Three major traditional divisions The ten Ogbes are connected with three major war/chief divisions: I Odogwu, I Uwolo, and I Iyase. These divisions also have historical importance in the community's traditional organization.

Other important institutions are Umunna – the family/kindred level (the smallest unit); Ogbe – the quarter level, Igbuzo community government – the highest community level. This shows a bottom-to-top traditional structure.

Festivals and cultural celebrations: Some known Igbuzo festivals include: Iwu Festival – one of the most prominent festivals, especially associated with Umuadafe and Ogbeowele. It involves purification, thanksgiving, cultural displays and preservation of traditions. Today according to the people, Ulor (Ichu-Ulor) Festival – celebrated by several quarters including Umuekea, Umuodafe, Umuidinisagba, Ogbeowele and others. Ine Festival, Ekwensu Festival, Iwaji (New Yam-related celebration)

Another interesting thing: Igbuzo people are historically known as Isu na Mba Ogu ("warriors from Isu") because of their warrior tradition and military history. So, in summary: Igbuzo is not just a town with ten quarters; it operates like a federation of villages with a layered leadership system from Umunna → Ogbe → Igbuzo, guided by elders, chiefs, war divisions and the Obuzor institution.

On the other hand, at the formal level of modern governance system, apart from the roles of the Federal and State Governments in fostering development and security of lives and properties, the Local Government Area (LGA) administration is overseen by an elected Executive Chairman. There is also the legislative arm of the LGA administration made up of Counselors elected from the political wards in the LGA. Communities in each LGA are grouped into political wards for purposes of representation and administration. Political participation is very keen in the communities and the main political parties with offices in the communities studied in Delta State are: All Progressive Congress, (APC), Peoples Democratic Party (PDP) and others.

### 4.10.7: Population and Socio-demographic Characteristics

#### 4.10.7.1 Population Size, Growth and Distribution

Delta State is one of the nine States created in 1991, excised from the old Bendel State. At its inception, it had nineteen (19) Local Government Areas (LGAs). Delta State as revealed in 2006 census had a population of *4,112,445*, comprises of *2,069,309* males and *2,043,136* females, distributed into about *890,312* households. It also encompasses a landmass or area of over *17,239.24* $km^2$ and this shows an average density of *238.6* persons per $km^2$ (NPC 2006). According to the 2006 census, Delta State, like the nation Nigeria, has witnessed much increase in her population with a total population of *4,112,445*. Meanwhile, with this population figure, Delta State now ranks the 12$^{th}$ most populous State in the country…and the 2$^{nd}$ most inhabited among the nine (9) oil producing States that comprises the Niger Delta Region. The population is being estimated to be growing at an annual growth rate of 3.2% just as that of the entire country (FGN, Official Gazette, 2007). The population is being estimated to be growing at an annual growth rate of 3.2 just as that of the entire country.

Meanwhile, the 2006 population census of individual community was not published till date, however, Knowledgeable individuals and key informants whose views were sought as to what their community estimated population might be as at the time of the study have near an exaggerated estimate of how many persons may be inhabiting the Ibusa community tobe 45000. Although, the figures appear very bogus even if the number of houses, physical size and internal migration and pull-factors (growth-inducing factors) are considered.

Natural increases, like excess of births over deaths and migration are the two most known determining factors of population growth. The population growth may have been influenced by the mere proximity to state capital and entitlements given to the various community leaders. In addition, population projection using the exponential model reveal practically that rather than population growth occurring in constant increments over time, i.e. linearly, the rate of growth changes over time, growing faster as the population size increases. It is therefore, to be expected, why the proposed Rainoil Mini/500MT LNG Blending Plant stakeholder community has actually witnessed an increase over the years.

### 4.10.7.2: Population Growth Rate

Population growth is determined by the demographic processes of fertility, mortality and migration. Considering the impact of these demographic processes, NPC has estimated annual population growth across Nigeria at 3.2% (NDHS, 2008). Fertility rates are influenced by a number of factors in the communities studied, which include early procreation and the practice of polygamy. The most commonly used measures of fertility in Nigeria are the Total Fertility Rate (TFR) and the Crude Birth Rate (CBR). The TFR provides an indication of the total number of children a woman will have in her reproductive life time. There were no available TFR values for the communities and LGAs, but the National Bureau of Statistics (NBS) in its Annual Abstract of Statistics (ABS), 2010 provides a TFR value of 4.6 for the South-South geo-political region and 5.9 for the nation. The implication of these values is that the rate of fertility in the South-South states, including Delta is lower than the national average. Another measure of fertility, the Crude Birth Rate (CBR) describes the relationship between the number of life births per 1000 of the population and the midyear population in an area. Expressing the CBR in percentage, the NBS estimates the national CBR at 13.65% and in Delta State at 16.09% (ABS, 2010). Delta State has a higher CBR of 2.59 % than the national average of 1.78%. A major factor that has influenced mortality in the communities is the non-availability of adequately staffed and equipped medical facilities.

Migration is another factor that is responsible for population growth rate in Nigeria. This has been mostly characterized by a rural to urban movement of individuals and families. Overall, results obtained from the survey of the communities indicate that about 85% of respondents across the study area were non-migrants and 15% were migrants. Specifically, the figure was 85% non-migrants to 15% migrants across proposed Rainoil Mini/500MT LNG Blending Plant stakeholder’s community.

### 4.10.8: Socio-Economic Characterization and Age Distribution of Respondents

The age distribution of respondent is dominated by youth ranging between 20–49years (52.8%). About 42.4% were found to fall within the age bracket of 50–69 year while above 70 years accounted for only 4.8% as depicted in (***Figure 4.16).*** This result suggests that the population of the project people has great potentials for future growth. The age range is in conformity with the local and state government age group where the bulk of the population falls with 15-64years of age.

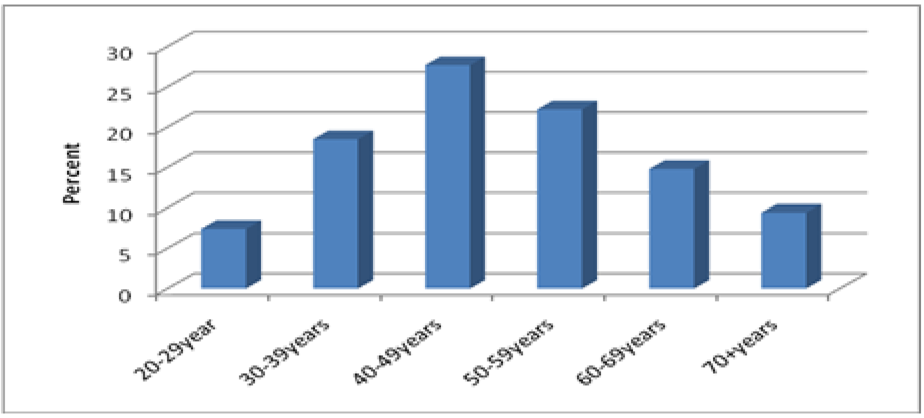



**Figure 4.16: Age Range of Respondents**

### 2.4.1: Household Size and Marital Status of Sampled Population

Sizes of families vary from community to community and this is influenced greatly by the cultural attitude of the people. Another critical determinant of household size and marital status is economy of the settlement as well as educational status/awareness of the resident population. Specifically, the average household size in the proposed Rainoil Mini/500MT LNG Blending Plant stakeholder communities was 5.3 according to number of households and total population in (NPC 2006); socioeconomic survey of the sampled communities revealed however, that household sizes had since increased beyond this level.

Women have an average of 5 children and average household size approximates to 5.3. If other dependants living in the households are added, (a minimum of 2 and maximum of 5 was reported within the communities), household size now comes to 10. This trend of large household sizes can be attributed to several reasons in the studied communities in particular and the South-South (Niger Delta) region as a whole. For instance, people marry at a relatively early age thereby extending their period of child bearing. On the other hand, the men marry more than one wife (i.e polygamy) as well as keep other concubines. On the average, about 55.3% of the sampled respondents are married while about 30.2% are single. Widows' people account for about 4.4%, Divorced 5.3% and Separated 4.8%. This is in line with the Delta State marital status where the married and single are higher with 32.3% and 57.3% as depicted in ***(Figure 4.17).***

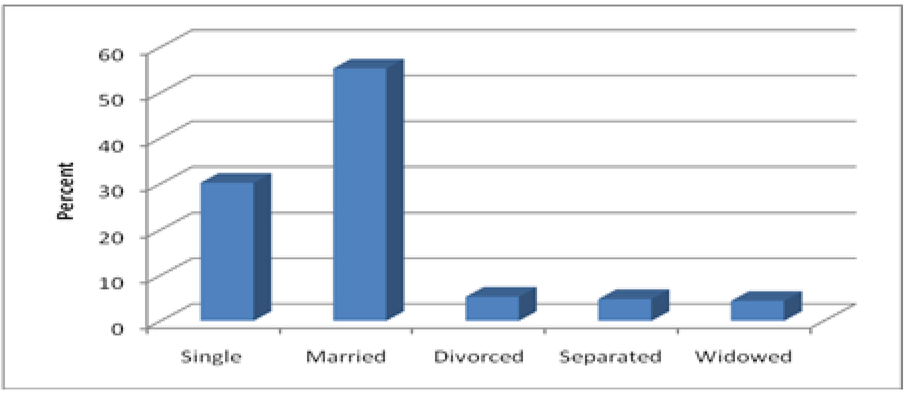



**Figure 4.17: Marital Status of Sampled Respondents**

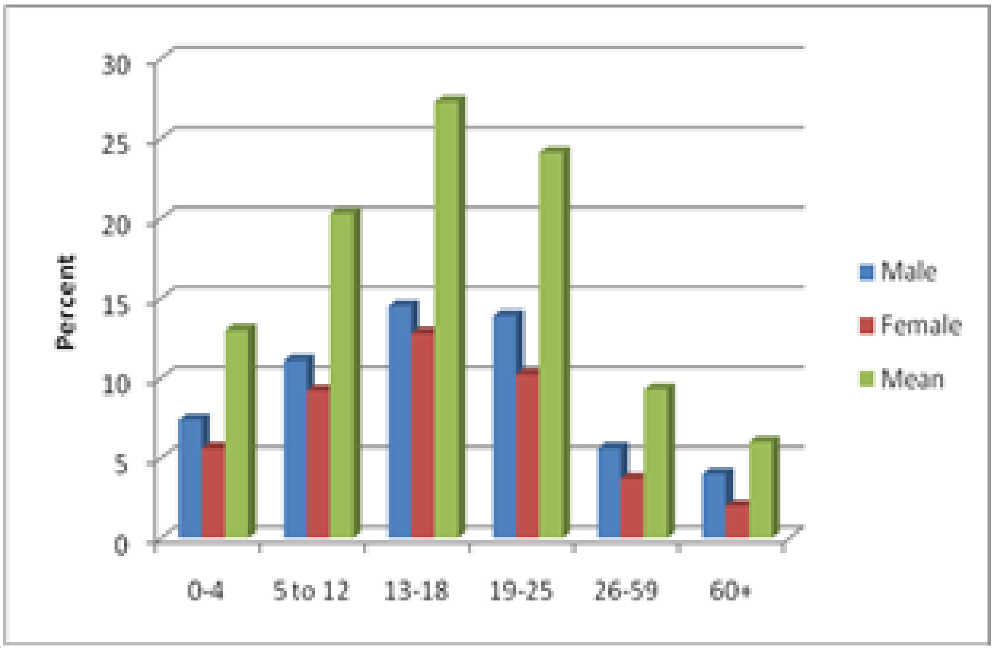
**2.4.2: House Hold Size**

Households in the study communities were also found to have an average of seven members**.** This is explained by the culture of the people which permits polygamy with men marrying more than one wife to procreate children that support activities in their traditional occupations of farming and fishing (UNDP, 2006).

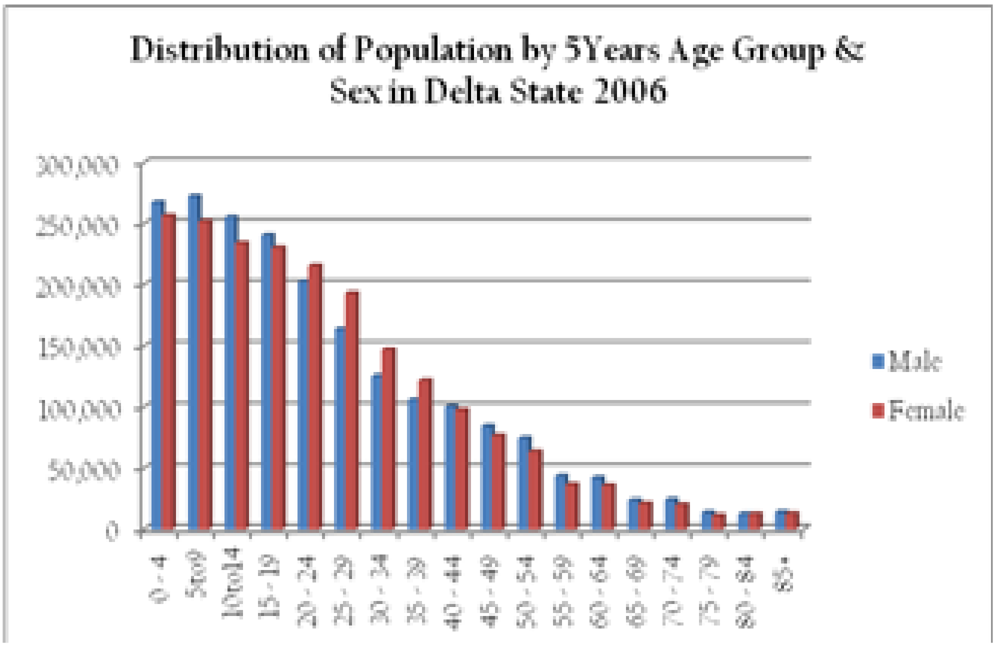
**4.10.9: Household and Population Structure (Age/Sex Distribution and Ratio*)***

***Age and Age-Sex Structure***

Age and sex are important demographic classification variables. As high as 31.3% of the household population is aged 0-12 years while 25.3% is within the 13-18 years age bracket. Together therefore, children make up 56.6% of total household population. Almost half (37.4%) of the household members are within the productive workforce age cohort of 19-59 years. Household members aged 60 years and above are few, constituting only 6% (***Figure 4.18a &b)***




*a)*.




b*)*

**Figure 4.18a: Age and Sex Structure of Sampled Households Figure 4.20b: Distribution of population by 5years age Group and Sex in Delta State**

**Source: NPC 2006**

This household Age-Sex composition conforms to what was found in Delta State, and indeed Nigeria's population age-sex structure (National Population Commission, 2006). By this structure, the population is overwhelmingly loaded from the lower age-cohorts with the bulk of the population made up of persons below 18 years, and descriptively classified as children (NPC, 2002). As a result, communities in Delta State have high dependency ratio with child dependency ratio (for age group of 0-14 years) of 31.23%, disaggregated into 16.37% for males and 14.86% for females. The implications of this age profile are that the population is young and growing and places heavy burden of dependence on the workforce population especially with regards to provision of education and health care services for the young and medical care for the aged. The household structure of the proposed Webrite gas plant stakeholder communities shows that there are more male (64.6%) heads of households than females (35.4%). The three (3) different type of male-headed household structures are as follows; (one husband and one spouse), polygamous, and single male (male with no spouse, including widowers and males that have never been married). Traditionally, the male is responsible for all the major household decisions.

The socioeconomic survey of the communities also showed that households' structural composition is typically pyramidal; i.e. broad-based with the younger ones predominant and the aged fewest in proportion. On the average, children aged 0-4 years (infants) is about 11.3% of the household members and children aged 5-12 years (primary school age) makes-up about 17.1% of the population. The age range of 13-18 years (Secondary school age) is about 21.4% while 19-25years (Tertiary education) made up of 20.5%. Also 20.1% make up 26-59 years (active working proportion) and the aged (60 years and above) make up 10.8% of the household composition. The socio-economic data also indicates that most of those surveyed are adults of at least 20 years old. On the average, about 25.9% and60.9% of the community respondents were respectively in the 20-39- and 40-59-years age brackets, 37.7% were aged 40-49; 23.2% (50-59) while 13.2% were aged 60+ years and above (**Figure 4.19**). Sex distribution of the population in the community shows the males are more in number constituting approximately 62.2% to the females' 37.8% of the population (**Figure 4.20**). According to the 2006 census, the males outnumbered the females. At the State level, the male-female ratio is almost equal at 50.4% males to 49.6% females

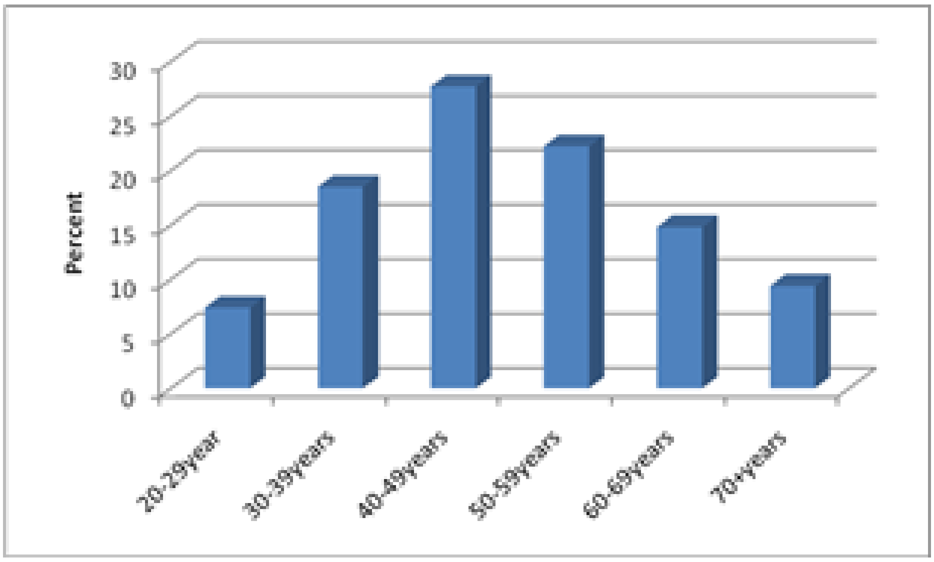



**Figure 4.19: Age Range of Respondents**

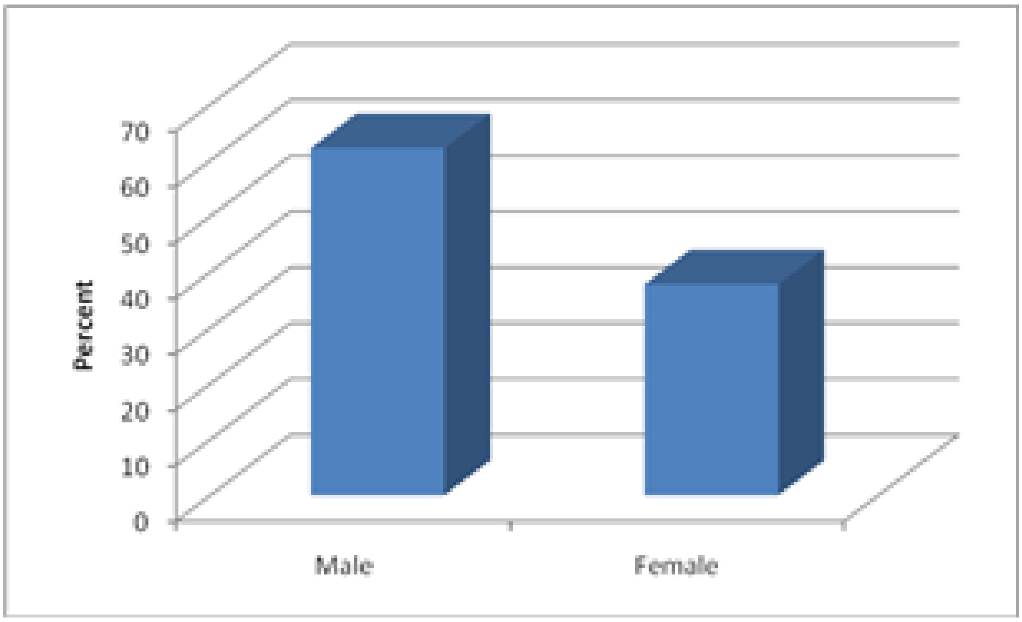
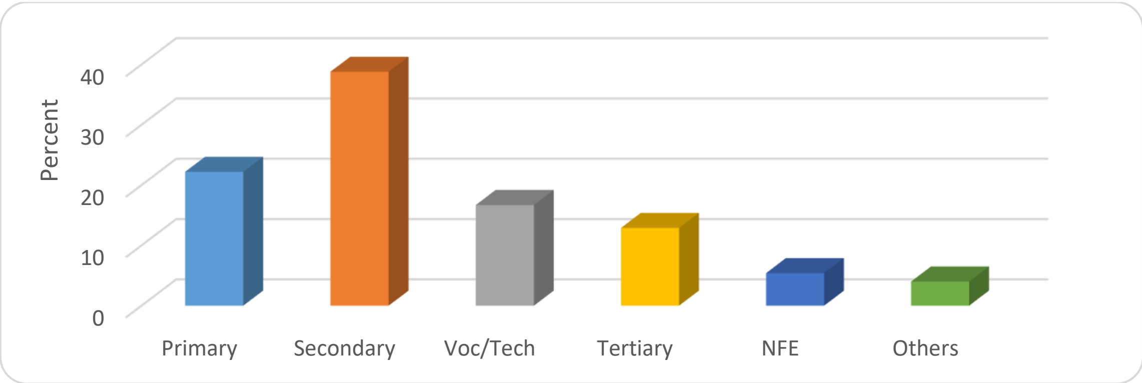


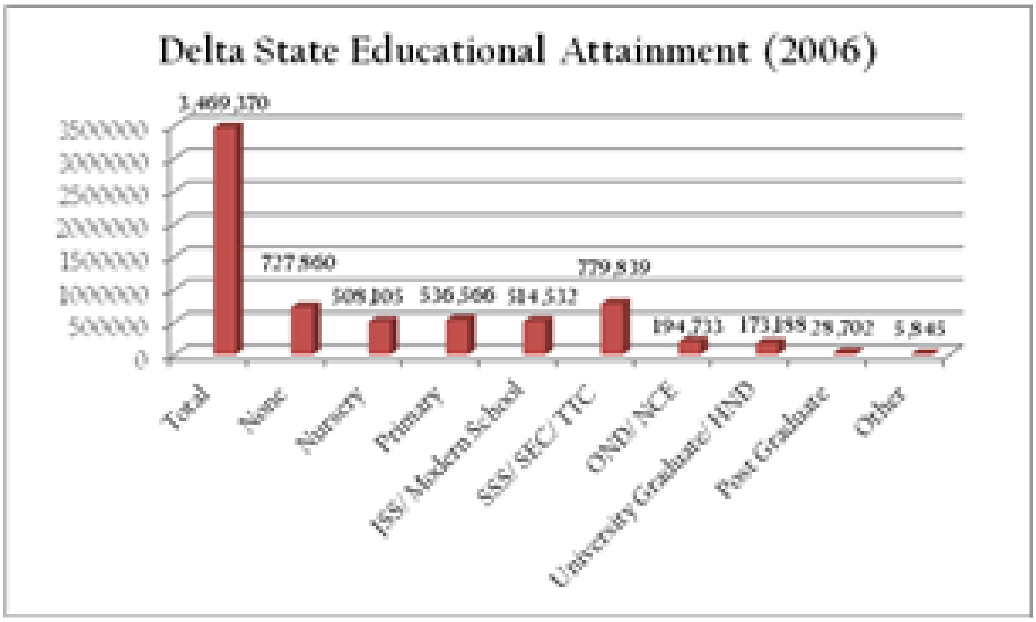

**Figure 4.20: Sex Respondents**

### 4.10.10: Educational Status and Characteristics

Education is a key determinant of lifestyle and social status among individuals. Studies have consistently shown that educational attainment is highly correlated with socio economic wellbeing, health behaviours and attitudes. A large proportion of the sampled population has formal education indicating a literate society. The common classes of educational attainment among the sampled population are the tertiary, post primary and primary education. On the average, 12.9% of the respondents had tertiary education training. Those with post primary (secondary) and primary education accounted for 38.8% and 22.2% respectively. The possession of vocational/technical education among the sampled population is quite high (16.7%) and this is good on occupational skill needed for prospective employment positions that may be offered to members of the community. Those of NFE constitute 5.4% and 4% others (**Figure 4.21 a and b**).




a)




b)

**Figure 4.21a & b: Education attainment of respondents & Delta State Educational Attainment.**

Beyond the aggregate figure for Delta State, the literacy level amongst the respondents in the project area of influence, indicate that mostly the retirees make up the bulk of those with tertiary education. 5.8% of the respondents had either Teachers certificate while some have other training in addition to WASC/GCE; Another 5.1% of the respondents had intermediate non-degree qualification such as OND. Furthermore, about 16.7% and 22.3% of the respondents fall within the categories of junior and senior secondary school certificate holders. Also, 16.9% had vocational/technical education while 25.6% had primary school leaving certificate, 6% and 1.6% had non-Formal education and others respectively (**Table 4.15**).

**Table 4.15: Educational Status of Respondents in the Study Area**

| **Educational Category** | **Male** | **Female** | **Total** | **Percentage** |
|---|---|---|---|---|
| No Formal Education | 11 | 14 | 25 | 6 |
| Primary | 55 | 51 | 106 | 25.6 |
| Junior Secondary | 37 | 32 | 69 | 16.7 |
| Senior Secondary | 50 | 42 | 92 | 22.3 |
| Post-Secondary (non-degree) | 12 | 9 | 21 | 5.1 |
| Post-Secondary (degree) | 14 | 10 | 24 | 5.8 |
| Vocation/ Technical education | 40 | 30 | 70 | 16.9 |
| Others | 2 | 5 | 7 | 1.6 |
| **Total** | **183** | **142** | **413** | **100** |

**Source**: Field Survey, 2026

### 4.10.11: Livelihood and Micro-economy

#### 4.10.11.1: Occupation, Employment and Income Generating Activities

Opportunities as well as constraints in a micro- and macro-economic life of a society are known to influence the socioeconomic characteristics of the inhabitants. These opportunities and constraints manifest as positive or negative effects on nutrition levels and health, geographic mobility, educational attainment, and overall quality of life. The economic livelihood activities in the proposed Rainoil Mini/500MT LNG Blending Plant stakeholder community depend much on the natural resource-base and traditional occupations like farming, fishing, hunting and lumbering. Farming and Fishing are the major activity of the people and majorly on crop farming, vegetable, maize, pepper etc. Artisanal fishing and processing of sea products, essentially drying, are part of economic livelihood activities in the study communities. Fishing is done in the rivers and other water bodies around the communities.

Farm and fish products intended for sale are transported to various periodic markets. Residents of the proposed project community have their market usually held every seven-seven day. The people also carry their farm produce to Asaba, Onitsha and Ogwachi-uku and other major town around where prices are perceived to be higher.

The markets apart, there is considerable daily sales of goods in the communities. This type of economic livelihood activity is done by petty traders who hawk their wares and others who sell from shops. The shops are usually one room from which traders sell a wide variety of items like clothing, shoes and bags, electrical fittings, alcoholic and nonalcoholic beverages and stationery, among others. Some of the traders in this latter category include Aniocha, Igbo, Hausa, Yoruba, and the indigene (Enuani). Hawking is done mostly by women and children. Traders deal with a wide variety of goods and also operate on different scales and so their incomes vary. Indications from responses during interviews are that their monthly incomes are as varied as between N20, 000 to N70, 000, particularly those involved in farming.

Artisanship practices provide major forms of small-scale livelihood activities in the study communities. Artisanship practices in the study communities include making of crafts like tailoring, electrical works, welding, masonry and hair plaiting. These occupations account for 16.7% of livelihood activities across the study area.

Estimated monthly income from artisanship practices is between N20,000 and N70, 000. Some residents also work at other activities including providing internal transportation by riding commercial motorcycle popularly known as Okada and Keke NAPEP. Residents commonly engage in more than one livelihood activity. Engaging in multiple livelihood activities provides household members complementary sources of income. In many cases it is an indication that each of these activities only provides a subsistence income. Survey analysis revealed that, farming 25.5%, fishing 0% and trading 18.1% account for the primary occupation of the people respectively. Also, 9.5% of the population engages in technical/artisan jobs. Other economic activities include Business/Contracting 3.3% and unemployment 12.7%. Also 9.2% of the sampled populations are civil servants, students/apprentice 13.3%, industrial works 0.5% and others 3.3%. The 13.2% unemployment shows that employment issues are of serious concern in the proposed Rainoil Mini/500MT LNG Blending Plant project stakeholder communities ***(Figure 4.22)***.

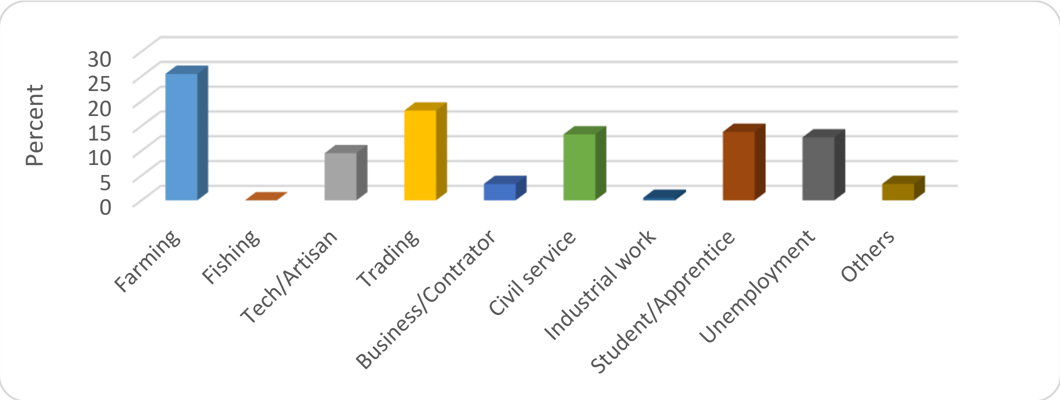



**Figure 4.22: Livelihood Activities in the Study Community**

### 4.10.11.2: Employment Status in the Communities

Residents of the communities experience employment and unemployment. The employed are engaged in one or more of the identified livelihood activities as identified in the preceding section. The Unemployed here refers to those who are ready and willing to work but are unable to secure one. During discussion and interview sessions, community sources indicate that several households among them had one or two unemployed members. They estimate the rate of unemployment among residents at between 25% and 30%. Sources at host communities estimated the higher figure at 30%. These figures conform to the unemployment situation in Nigeria. For instance, in its 2011 Annual Socio-Economic Report, the National Bureau of Statistics (NBS) estimated the level of unemployment among rural residents in the country as follows: Among the uneducated, the rate of unemployment was 22.8%, among primary school levers it was 22.7%, among JSS graduates it was 36.9% and among SSS graduates it was 22.5%. The age distribution showed that among 18–24-year-olds, unemployment rate was38.2% in the rural areas, among 25–44-year-olds it was 24.1% while for those aged 45-59 years it was 19.65 and among those aged 60-64 years it was 22.1%. The sex distribution of unemployment was 25.1% among males and 26.1% among females. This would suggest that the rate of unemployment across these communities is highest among females aged between 15 and 24 years whose only qualification is Junior Secondary School Certificate (NBS, 2011). The International Labour Organization (ILO), however, estimated that unemployment rate across Nigeria in 2014 was 10%. It also indicated that the main employment problem in the country was underemployment rather than unemployment (This Day Newspaper, 23 July 2014). The proposed Rainoil Mini/500MT LNG Blending plant project obviously will provide more employment for some residents of the stakeholder communities.

### 4.10.12: Income Levels and Distribution

Monthly income levels from primary and secondary livelihood activities in the communities are presented in **Table 4.16**.

**Table 4.16: Monthly Income Levels in the Study Communities**

| Income Range and Midpoint (N) | Community/Frequency | | Total of Study Community | |
|---|---|---|---|---|
| | Igbuzor | | (No) | (%) |
| | (No.) | Total Income (N'000) | | |
| 1,000-5,000 (2,500) | 0 | 0 | 0 | **0** |
| 6,000-10,000 (7,500) | 2 | 15.0 | 2 | **6.**2 |
| 10,001-15,000 (12,500) | 1 | 12.5 | 1 | 3.2 |
| 15,001-20,000 (17,500) | 1 | 17.5 | 1 | 3.2 |
| 20,001-25,000 (22,500) | 3 | 67.5 | 3 | 9.4 |
| 25,001-30,000 (27,500) | 3 | 82.5 | 3 | 9.4 |
| 30,001-35,000 (32,500) | 4 | 130.0 | 4 | 12.5 |
| 35,001-40,000 (37,500) | 8 | 300.0 | 8 | 25 |
| 40,001-45,000 (42,500) | 5 | 212.5 | 5 | 15.5 |
| 45,001-50,000 (47,500) | 3 | 142.5 | 3 | 9.4 |

| **Income Range and Midpoint (N)** | **Community/Frequency** | **Total of Study Community** | | |
|---|---|---|---|---|
| | **Igbuzor** | | **(No)** | **(%)** |
| | **(No.)** | **Total Income (N'000)** | | |
| Above 50,000 (52,500) | 2 | 105.0 | 2 | 6. 2 |
| Total | 32 | **1,085,000** | **32** | **100** |
| Community Average Income (N) | 33**,906.26** | | | |
| | | | | |

*Source: Field Data 2026*

The mean monthly incomes in the communities are as follows; Igbuzor N33,906.26. The modal income bracket at the community is N50, 000 and above. Given the mean income values and assuming naira to United States of America dollar (USD) conversion rate of N1130: 1USD and 30 days in a month, the daily individual incomes will be N1130 or 0.77USD. Using the midpoint of the modal income range (i.e. N52, 500) individual daily incomes in the community will be N1, 733.34 or 1.20USD. Daily incomes in the community are even lower than the World Bank extreme poverty income of 1.9USD. The depreciation in naira dollar exchange rate has further impoverished the people of the proposed project area.

### 4.10.13: Expenditure Pattern

The main items spend for by the households in the study communities include food (35%), education (20%), healthcare (10%), purchase of household items including groceries and utilities (15%), transportation (10%) and clothing (5%), as depicted in ***Figure 4.23***.

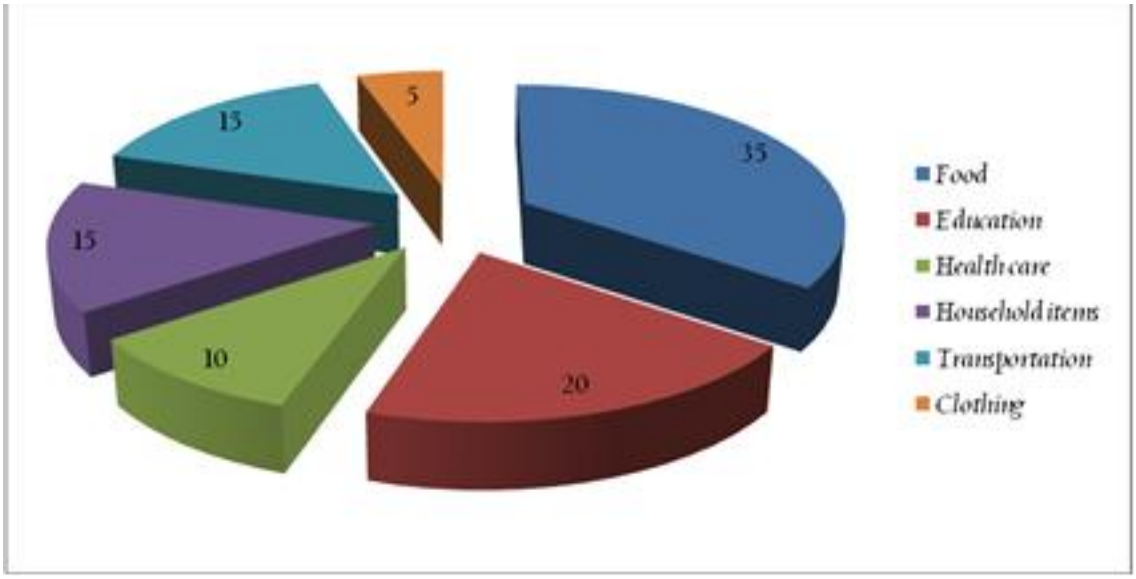



**Figure 4.23: Household Expenditure Pattern**

The major food items that are expended on are those that are either not grown or produced locally. These include beef and beverages. Expenditure on health care is quite significant. Many residents spend considerable sums of money on drug purchases from drug stores (‘chemists’) in their communities. Recreation and leisure are not significant expenditure items. Expenditure on food, education and health accounts for 65% of total household expenditure. These expenses are estimated to account for about 70% of their monthly incomes. Despite the foregoing, the primary economic activities in the study area revolve around farming and fishing. Both men and women are involved in farming and fishing. The youths dominate the private company employment and artisanship. There has however been a shift in economic livelihood activities. This, the respondents attribute to the availability of oil and gas employment opportunities in the area. It is pertinent to note that although farming and fishing activities is the major economic livelihood ventures, these are increasingly becoming less important income source since the activities of the oil and gas operation began. There is no longer bumper harvest of agricultural produce and fish catch have dwindled. Hence, the occupational shift from these two main employment sectors to oil and gas operations and services.

For those that are involved in farming, cassava is the most popular crop cultivated in the communities. Other important crops are plantain, oil palm, water yam, sugarcane, maize, banana, cocoyam, sweet potatoes, groundnut, okra, pepper, pawpaw and vegetables. Cassava (either in its raw form or processed into cassava flour/garri), plantain, oil palm and yam are the most important food and cash crops. However, cassava, plantain, banana, cocoyam, oil palm and maize yield more income to the households than other crops.

### 4.10.14: Religion, Customs, Belief System and Heritage

#### 4.10.14.1: Religious Affiliations, Customs, Belief Systems, and Heritage

A 100% response to administered questionnaire and Focus Group Discussants confirmed that Christianity is the predominant religion in the proposed Rainoil Mini/500MT LNG Blending Plant study communities. This indicates that a very high proportion of the resident population ‘’go to church’’ or associate with a religious organization, with a minority practicing the traditional African religion (ATR) and/or do not identify with any religion. The orthodox churches like the Anglican (CMS), spiritual (Christ Army Church – CAC) are easily the dominant denominations, while the presence of several Pentecostal sects was observed as sign-posted in all the nooks and crannies of the studied communities. For example, many churches were observed in the communities. The churches include the Roman Catholic, Anglican, Assembles of God, Redeemed Christian Church of God (RCCG), Brotherhood of the Cross and Star (aka OOO), and Apostolic Faith. Focused Group Discussion sessions and previous studies of the area have revealed that in spite of the overwhelming presence and influence of Christianity, the communities still retain some of their traditional beliefs. Thus, in practice, some of the Christians at the lineage and community levels participate in existing traditional festivals and religious rites.

In the affected communities, there are places that are considered sacred and ‘’unauthorized’’ to non- initiate. Trespassers are sanctioned for any trespass. Cultural and traditional practices relating to such ‘’forbidden grounds and forests’’, are either conducted at the individual level with the nuclear family or at the community level. Such sacred sites are regarded as the abode of the gods. In fact, the beliefs of the people as it relates to their existence are still very much reliant on the deities/gods. However, such sacred areas can only be trespass on conditions of making some sacrifice or appeasement by the priests in charge of the forbidden areas.

Amongst the most important of the peoples’ culture presently are their festivals. While generally, most festivals in proposed Rainoil Mini/500MT LNG Blending Plant communities are in commemoration of historical events or in honour of the spirits of departed heroic ancestors. Some of the communities with close familial affinity up till now engage in a few festivals which have bearing with their way of life and economic well- being. Again, in spite of the commemorative and religious coloration of the festivals, they also play highly aesthetic and recreational roles in the process (Okaba, 1999). For example 'Aziza festival' takes place every year without fixed date as the date is revealed by the deity through the Chief Priest and communicated to the people. These are the prominent festivals in the proposed Rainoil Mini/500MT LNG Blending Plant community. Other belief systems revolve around the common taboos, which forbid some acts like having sexual intercourse in the bush, and adultery. There are also few shrines in the communities that are not to be trespass by unauthorized persons. Violation of all laid down taboos is regarded as sacrilegious.

The people of the proposed Rainoil Mini/500MT LNG Blending Plant project area are also predominantly Christians and traditional religious practitioners. As revealed during the field work, a greater proportion of the samples surveyed are Christians while a few are traditional religion worshippers. As a result, too, Churches of various denominations are seen in the area. These churches include Anglican diocese, Assemblies of God, Redeemed Christian Church of God (RCCG) Apostolic Faith, Baptist Church, and Roman Catholic particularly. In spite of the Christian majority among the surveyed communities, some still believe in their ancestors and deities that they worship. In furtherance of traditional worship, there are shrines and forbidden forests scattered within the project area. These are held sacred by the people. Contact with some of these spots are restricted with the list of "dos and don'ts" which when violated attract very severe sanctions.

***Taboos***

In addition to the shrines (not mentioned here) and festival attached to them, the people of the people observed some taboos. These taboos are:

- Having sexual intercourse with a woman in the bush/forest,
- A woman under menstruation is not allowed to enter the shrine,
- Sleeping with another man's wife (adultery)

It is a general belief of the traditional worshippers that these shrines and forbidden forests provide their community spiritual protection against external aggression and promote progress. As a result, these shrines and forest are held in high esteem and ensure that nothing is done to desecrate them.

***Festivals***

Periodic cultural festivals and dances are also performed in the proposed Rainoil Mini/500MT LNG Blending Plant stakeholder community. Communal festivals are a function of both entertainment and spirituality. Such festivals are many and vary from community to community. A number of festivals are usually celebrated in the area. In addition, the ceremony also signifies resting period for the people of the area as no individual is allowed to be involved in any active work. In general, the festivals have impacted on the people of the project area by creating awareness of Christianity. Others include promotion of peace, and unity within and between the neighbouring communities. Masquerade dance also perform occasionally in the communities and usually take place annually during Christmas period to cleanse the land. Social disorders such as adultery, stealing, fighting with dangerous weapons like knife or cutlass, bottles or gun, having sex with a woman in the farm are among the customs and beliefs that attract serious sanctions. Offenders are harshly sanctioned, either by paying fine or pacifying the gods and/or ancestors.

**4.10.15: Family Structure and Marriage**

Most traditional communities are composed of the nuclear families, the extended family units and the lineage wards, a conglomeration of which make up a settlement (Okaba, 1999). An amalgam of three to eight nuclear families of common descent constitutes an extended family unit, and these have residential locations that are easily distinguished. Four to six of these extended families make a lineage ward, all sharing a common ancestry (Okaba, Ibid.) Polygamy is a widely practiced form of matrimony. In fact, monogamy symbolized social degradation and failure, while polygamy symbolized success. Households are partrilineal and patrilocal, both serving as basic residential and economic units. The marriage custom of bride price payment on woman and marriageable girls is widely practiced within the study area. The traditional marriage which requires the kith and kin of both families to gather while the bride price of the girl is paid. On paying the bride price as well as all traditional rite is done, the offspring belong to the man. On the other hand, where bride price of a woman is not paid, the offspring(s) more often than not belong to the woman's family. The categorization of the marriage custom as described here influences patterns of kinship relations and inheritance.

### 4.10.16: Housing

#### 4.10.16.1: House Types

Housing is a basic social need and an integral part of the human environment and the physical structure of settlements. Housing has been defined by WHO as "residential environment which includes in addition to the physical structure that man uses for shelter, all necessary services, facilities, equipment and devices needed or desired for the physical and mental health and social well-being of the family and individual" (WHO cited in Owei O. et. Al., 2002). Housing in the communities is a mixture of modern and traditional designs and construction materials. A few houses have modern designs and they are built with utilities like kitchen, toilet and bath. Most houses in the communities are also constructed with stable and permanent materials like cement blocks and roofed with corrugated iron sheets.

Most houses across the proposed Rainoil Mini/500MT LNG Blending Plant project communities are bungalows and flats. The bungalows are built with many rooms and are mostly multi tenanted. A few houses are built with single rooms or as self-contained units of room and parlour. Bungalows account for a significant number of houses in the communities. Some of the houses are owner occupied houses; some, especially the flats, have toilets and baths located in-house; but most are not provided with these utilities. Some also have kitchens in-house. However, the survey analysis revealed 0% of the housing type in the host communities to be mud with thatch roof, mud houses with zinc roof 22.3%, wood/plank with zinc roof 1.8%, zinc with zinc roof 1.8%, while concrete houses with zinc roof are more in the communities with 65.6% and those others houses account to about 1.7% (**Figure 4.24**).

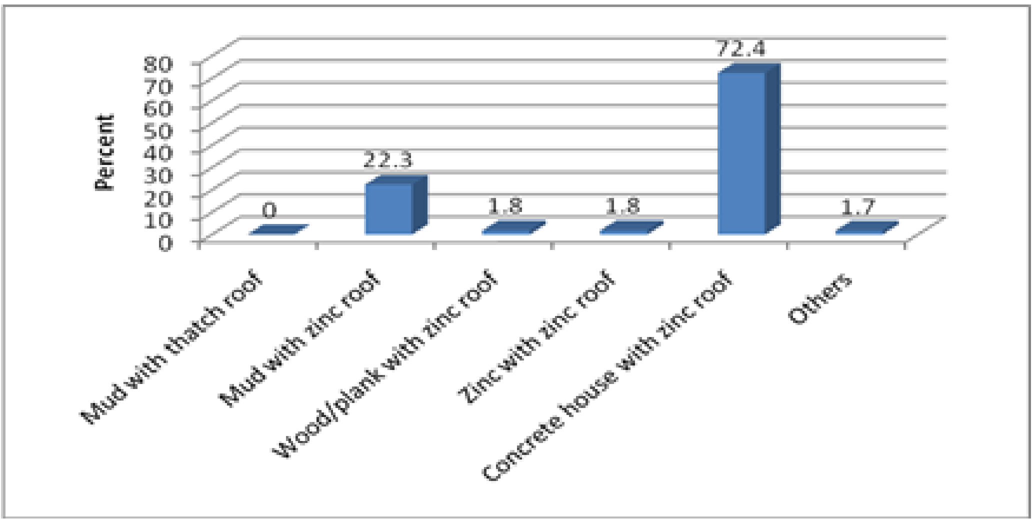



**Figure 4.24a & b: Housing type & Housing unit**


**Plate 4.12: Housing type/quality in proposed Rainoil Mini/500MT LNG Blending Plant stakeholder community**

**Availability and Cost of Rental Accommodation**

Rental accommodation is available in the communities. A number of residents, including indigenous members of the communities, live in rented accommodation. Value of house rent in the communities varies according to the construction material. A room in a house built with mud walls and roofed with zinc attracts N15000 per month across the communities while a one room accommodation in cement block house costs N25000 monthly while a room and parlour in a similar house costs N35, 000. Flats, two and three bed rooms, cost between N40, 000 and N50, 000.

**Available Housing Utilities**

Houses in the communities are built with limited utilities. For instance, as a result of the problem of public power supply, residents use alternative sources like private electricity generators, kerosene lamps, torches and candles to light up their houses. Common sources of energy for cooking household meals are firewood and kerosene. About 90% of households across the communities cook with firewood. The proposed Rainoil Mini/500MT LNG Blending Plant project stakeholder communities' drinks and cook from river/stream water around them. However, some have functional public and private borehole in their communities.

Generally, houses in the communities do not have running pipe borne water because the public supply does not have the distribution network that facilitates delivery to houses in the communities. A few houses have private water boreholes installed, and these are the most reliable sources of water to many residents. In addition to the private boreholes, residents use water from the river and rain water.

**4.10.17: Existing Businesses**

Existing businesses in the communities are small scale. They comprise primary production activities as represented in the two traditional occupations of farming and fishing, commercial activities represented in trading, in shops and markets. The community has several main provision store and drug stores. Apart from these, there are business centers, welding shops, carpentry and furniture making shops, electrical and electronic repair shops, motorcycle repair and tire vulcanizing shops. Another existing business is transportation by commercial motorcycles, Keke NAPEP and motor vehicles. Available businesses in the study community are in the informal sector, there are no organized private sector businesses and industries in the community.

**Banking and Informal Credit Institutions**

Residents do their banking transactions mainly at Asaba, Igbuzor and POS stands located in every nook and cranies of the community. Existing informal credit practices among residents are the traditional contribution and Osusu. Contribution entails a group, usually made up of friends and acquaintances, who commit themselves to a fixed monthly contribution over a number of months, usually determined by the number of members of the group. A member takes each monthly contribution, and this is done in rotation until every member has had an opportunity. For participants, this represents a source of funds for business investments, payment of fees and bills and purchase of various items, among others. Osusu, on the other hand is organized by an individual who collects money from participants in the scheme. The sum collected is agreed with the participant, the duration is varied but mostly daily or weekly. The total sum collected, less an agreed amount (usually one daily or weekly collection, depending on agreed frequency of collection) is returned to the participant at the end of the month. Osusu is common among petty traders and artisans and it provides some savings which is used at month end to pay salaries of their assistants and purchase essential materials for their trade. Usually the person who organizes the 'Osusu' deploys the funds collected as short term credit to micro and small scale businesses and charges an interest.

### 4.10.18: Land Use and Resource Harvesting

#### 4.10.18.1: Available Resources

The proposed Rainoil Mini/500MT LNG Blending Plant project community is endowed with a lot of natural resources. These resources have been exploited by generations of residents, and have kept and sustained the continuous human settlements in the entire area. The resources are the water bodies, the forest and the land mass. Water bodies in the study area include the rivers, ponds and wetlands. Ponds and wetlands are situated in bushes and forests around the communities. These water bodies yield the fishes on which the communities depend for food and livelihood. The forests are home to a number of resources including timber, firewood, economic trees like the raffia and bush mango (Ogbono). The timber is useful in building houses and supports canoe repairs activities. The land provides for the physical development of the communities including housing and infrastructure. It is a major resource for farmers as it supports the growing of a variety of crops like plantain, cassava and vegetables etc. A traditional natural resource conservation practice among farmers is shifting cultivation and its attendant bush fallow system practiced in the communities. The practice requires that farmlands are cultivated for a period and left fallow for a number of years. The period of lying fallow allows for the farmland to regenerate naturally. During the fallow period also, farmers cultivate alternative farmlands which had been left fallow in the previous period. This is a common cultural practice that has served to protect and conserve the communities' farmlands, which are a valuable natural resource, from excessive exploitation.

**Land Ownership and Tenure**

The Land Use Act of 1978 provides the framework for land ownership and payment of compensation for land acquisition for development purposes in Nigeria. However, some of its provisions like the ownership of all lands by the Government have not been well received, especially in southern Nigeria (including Delta State and the proposed project community). The rejection stems mostly from the socio-cultural significance of lands. Therefore, in spite of the law, communities and families still assert their ownership rights over lands. Lands in the communities are primarily owned by extended families, compounds and the community. In the communities, families and compounds own lands. Ownership rights over lands are handed down from one generation to another within the extended family, compound and community. Such inherited land is put to any use as desired by the owners. These are the lands on which family, compound and community members build their houses. They are also allocated to members for use as farmlands and for other economic purposes. These lands revert back to the families and compounds at the end of the farming period. Farmlands can be leased by non-family and compound members. Such lands similarly revert back to the owners after the period of lease. Lands are managed by males within the extended families and compounds. ***Figure 4.25*** shows that 64.4% of lands are owned through family inheritance, 21.4% bought it, 8.9% rented/lease it, while 0% sharecropping and 5.5% others.

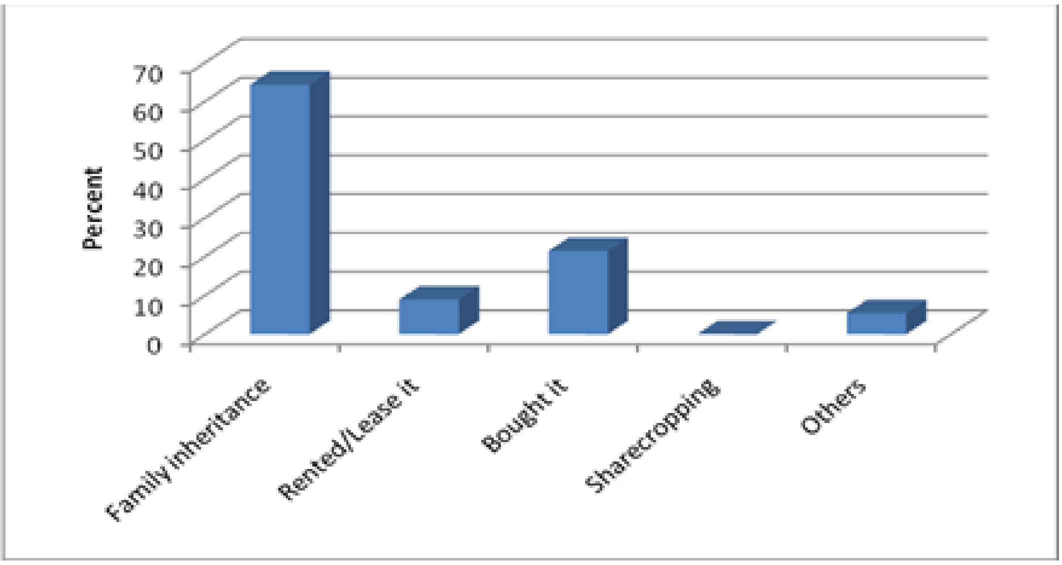



**Figure 4.25: Land ownership system**

## Classification of Land Use

Land in the proposed Rainoil Mini/500MT LNG Blending Plant project affected community is an invaluable resource. Traditionally, these have been used over the years for farming and housing, and in more recent times there have been additional uses for infrastructural development and industrial purposes. Residents were conscious of a gradual decrease of the lands in the community over the years. Their perceptions and estimates of the proportion of lands put to various uses and lands lost to natural factors are presented in ***Table 4.17a***. Most of the lands have been put to agricultural use. Land loss has also mostly been attributed to the natural factors of erosion from the river and rain fall.

**Table 4.17a: Land Use Structure in the proposed Rainoil Mini/500MT LNG Blending Plant Project Study Area**

| Land Classification | Communities/Frequencies (%) |
|---|---|
| | Igbuzor |
| Agricultural | 50.0 |
| Industrial | 10.0 |
| Housing Development | 25.0 |
| Institutional (Infrastructure) | 10.0 |
| Loss from natural factors | 5.0 |
| Total | 100.0 |

**Source: Field Survey, 2026**

**Land use Tenure System and natural Resources**

Land use and ownership system in any society is generally governed by a tenure system evolved over time and determined by the perceived demand as well as the potential and actual social pressure associated with its supply and use (Powell, 1995, Swallow and Kamaro, 2000). Land use pattern visible in all societies include public land use, commercial land use, industrial land use, recreational land use and social land use. As in the case in most communities in the Niger Delta area, land ownership is rested in individual, families as well as communities.

As shown in ***Table 4.17b***, the predominant land tenure system practiced in the proposed Rainoil Mini/500MT LNG Blending Plant stakeholder community was individual ownership (60.5%), family ownership (20.5%); communal (12.4%); while rented/leased was 6.6%. FGDs discussions conducted with members of the surveyed community confirmed the arrangement. They also agreed that access to land was through inheritance while control is left in the hands of the individual families and communities that owned bush land. In most cases community's lands are used for developmental projects such as schools, health care service.

**Table 4.17b: Natural Resources Assessment of proposed Rainoil Mini/500MT LNG Blending Plant sampled community**

| Community | Tenure Right | | | Access to land rent inheritance | Access to forest free (yes/no) | Access to water (yes/no) | Presence of forest reserved (yes/no) | Land control | development habitation and cemetery |
|---|---|---|---|---|---|---|---|---|---|
| | Land individual/family/ community | Forest individual/family/ community | Water/Lake Community | | | | | | |
| Igbuzor | C<br>F | F<br>C | C | Inheritance | Yes | Yes | No | F<br>C | ✓ |

**Source:** Field survey, 2026

**C** = Community, **F** = Family, **I** = Individual

### 4.10.19: Infrastructure

#### 4.10.19.1: Functional Status of Available Infrastructure

The infrastructural framework in the proposed Rainoil Mini/500MT LNG Blending Plant study community is made up of a few physical and social amenities. Some of the available amenities are functional while some are not. Most of the amenities have been provided by governments, and development agencies. The physical amenities include paved access roads, internal roads, community halls and telecommunication services. Social amenities consist mainly of education, health, water supply and electrification facilities.

The proposed project community is accessed by paved road. They also have some paved internal streets of varying lengths. The community is accessible through Ogwashi-Uku-Asaba Road. Taxis/Bus from Asaba to the proposed project site cost N1500 per passenger. Internal transportation in the community is by commercial motorcycles which cost N500-N1000 per passenger depending on the distance. Another major physical infrastructure in the community is Telecommunication services. Telecommunication services from GSM service providers (MTN, Airtel and Glo) are received in the community, though depending on your network and position.

The community has public primary and secondary school. The primary schools run classes 1-6 and the secondary schools have JSS 1-3 and SSS 1-3 classes. The community has electrification facilities and connected on the national grid. However, the people like other part of the country have power once in awhile and depend more on their individual generating set.

The community has market built with open and lock-up shops. The markets are periodic. The youth organize themselves into vigilante groups. The community does not have any developed public recreation facilities. Residents recreate by playing football in the school football fields or swimming in the river. Some stay at home and watch television for few who have television and can afford running cost of generator.

***Estimated Monthly Personal Income***

Personal income levels of self-employed community members are always difficult to access as typical of most Nigerian households. Many do not keep records and are therefore uncertain of the gross or net amount actually earned from self-employment. Most times, respondents inflate income figures on the assumption that such information could give some advantage in times of compensation payments. However, it is important to note that information on income should be handed with caution because of the high degree of unreliability.

Personal income levels of the people are typical of agrarian community, wide variation and meagre and range from N1,000 to over N50,000 per month. As shown in ***Figure 4.26***, 0% earning less than NGN 5,000 in a month, 0% of the population had income in the bracket of NGN5001-10,000, 5.9% earn between NGN10001-15000. Also, 9.2% and 10.5% earn between NGN15001-NGN20000 and NGN20001-NGN25000 respectively. While 7.4% also earn between NGN25001-NGN30000, 21.8% earn NGN31001-NGN35000, 22.3% earn between NGN35001-NGN40000, 5.6% earn NGN40001-45000 and 5.6% earn NGN450001-NGN50000 while 11.7% earn N50000 and above per month. Residents who are into Business however, earn better incomes. Generally, the income level of the proposed project area is low. This could be due to the meagre income arising from their sources of livelihood and lack of others sources of additional income to supplement their main income.

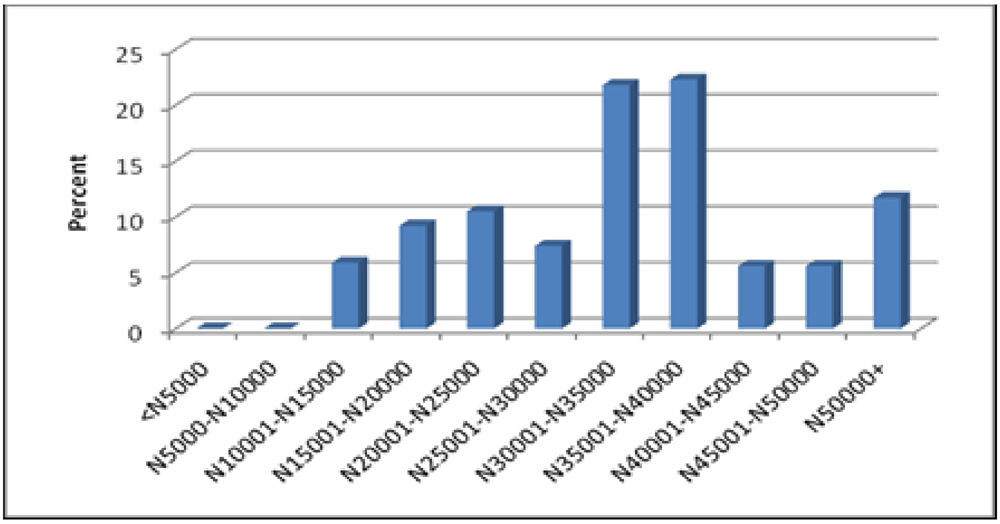



**Figure 4.26: Estimated income of respondents/month**

**Available Social Infrastructure**

Availability and access to basic social infrastructural facilities and a reasonable level of income have been used to measure the quality of life of people. The proposed Rainoil Mini/500MT LNG Blending Plant community visited or sampled has some existing social infrastructure in different status and levels of functionality.

***Educational Institutions***

The proposed project community sampled has primary and secondary schools. The schools are well equipped and fenced round with gate courtesy the successive Delta State government from Chief James Ibori to the present state government of Governor Sheriff Ovwbowereh. In addition to public primary and secondary schools, are many private schools. On the average each class is having about 40 pupils with one class teacher, which is contrary to UNICEF standard of 36 pupils/class.

***Electricity Supply***

Electricity supply in the area is mainly from Benin Electricity Distribution Company (BDEC). Though there is electricity power but like in every other part of Nigeria, the supply is not regular in the community. Power supply has therefore formed one the expectation of the people. The people currently depend mainly on generator and for those who can't afford generator uses local lantern and candle light in some homes. Some respondents claim to spend between N20000.00- N40000.00 on fueling of their gen set on monthly basis.

***Water Supply Facilities***

Available data from the Federal Office of Statistics (National Bureau of Statistics) reveals that water in the majority of Southsouth states comes from unsafe supply facilities. These include rivers, lakes or ponds, unprotected wells and boreholes. The Bureau however, classifies available sources of potable water for household use as pipe borne, untreated pipe, borehole, protected well, unprotected well, river/lake/pond, vendor trucks and other categories.

The202elieve rely more on public borehole water, and few use hand dug well and sachet water (pure water)/bottle water as source of water supply. However, from the survey analysis 0% rely on rain water for source of domestic water, 0% depends on rivers/stream, 2.4% uses own hand dug well, 57.5% (public piped/tap), 24.1% (private piped water), 12.2% (community borehole), 2.1% buys from tanker/truck/vendor or private owned borehole owners and 1.7% others (**Figure 4.27**). However, when compared with Delta State distribution of households by source of water for drinking and cooking, the use of rainwater conformed to proposed Rainoil Mini/500MT LNG Blending Plant project stakeholder community' source of water but contrary to the use of stream/river/creek where it is 0%

compared to NBS data of 30.8%. This is so because; the proposed project community has functional borehole water. Again, according to NBS data 29.3% uses borehole and this appears to be true with the study community, 57.5% who rely on borehole water, *(See **Figure 4.27**).*

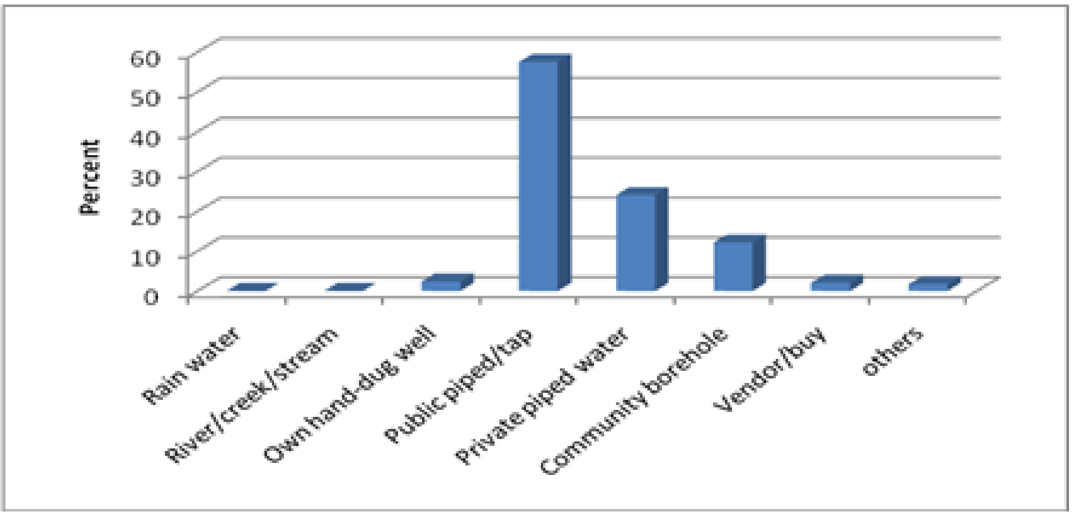



**Figure 4.27: Source of water supply**

## Recreational Facilities

There are no sources of recreation, meetings and dancing spots for members of the proposed project stakeholder community. There are town halls, no swimming pools and even club/rest houses. Meetings are held at the town hall and most cases at the President General's place. The primary and secondary school are used for playing of football. There are no public viewing centers in the community, in the case of watching international matches; however, paid viewing center could be seen in some of the community. The community indeed is in need of recreational facilities.

## Communication and Transportation

The the proposed Webrite gas plant project stakeholder communities sampled are accessible by land. The common transportation means/system consists of motor vehicle, Keke and Okada. Be that as it may, vehicular traffic in the area could not be described as high. In terms of communication, the area is also accessible by the MTN, Glo and Airtel GSM mobile system, though depending on the network and position, in some area it fluctuates.

**Conflicts and Conflict Resolution**

Conflict in the area predates the advent of oil and gas exploitation. Most of these conflicts were related to issues of land ownership, possession of palm oil bearing land, quests for autonomy and struggles for leadership. And now are conflicts arising from issues surrounding crude oil exploitation. In the Niger Delta, where oil exploration has been going on since 1960s, causes of conflict has always been between communities and companies which include: Non-recognition of community as stakeholder, oil spillages, border/land disputes, agitation for employment, refusal of companies to repair damaged roads, non-payment of compensation, non-compliance with court rulings and orders, failure to honour MoUs perceived intimidation of the communities, perceived “divide and rule tactics”, and ineffective communication channels. These conflicts obviously may surface from time to time but from our interaction with community members during Focus Group Discussion (FGDs), Rainoil is being commended for starting on a good footing, at building community-company relationship while they (the community members) suggested the (Rainoil) can always improve on the existing cordial relationship.

Be that as it maybe, the conflict resolution strategies in the study area are through dialogue in special meetings summoned by the most elderly person and his cabinet. Traditionally, issues are discussed at the lower levels of family, age grade and women or taken directly to the community leadership. In addition, appeals and summons are common processes utilized at community level. Issues are referred to the police and courts, when they are criminal offences that are mandatory to be reported and when the resolution of the conflict overwhelms community leadership. Conflict resolution at community level could attract penalties such as fines, seizures of assets and ostracizing.

### 4.10.20 Community Health Environment and Related Issues

**(i)*Water Supply Facilities***

Increasing access to improved drinking water was part of Sustainable Development Goal (SDG) (ensuring environmental sustainability), adopted by Nigeria and other nations globally (United Nations General Assembly, 2002). The goal in Nigeria was for 77% of the country’s residents to have access to an improved drinking water source by 2015 (Federal Republic of Nigeria, 2010a). Nigeria met the SDG target; the proportion of the 2015 population that gained access to water since 1990 amounted to 48% (UNICEF and WHO, 2015). The statistics however, showed that while some 69% have access to improved sources of water, only 2% have piped water on premises, some 21% depend on 'other' improved sources while 10% still sources water from ''surface water'' susceptible to contamination.

A number of indicators are useful in monitoring household access to improved drinking water. The source of drinking water is an indicator of whether it is suitable for drinking. Sources that are likely to provide water suitable for drinking are identified as improved sources. These include a piped source within the dwelling, yard, or plot; a public tap/stand pipe or a borehole; a protected well or spring; and rainwater (WHO and UNICEF, 2010). Lack of easy access to a water source may limit the quantity of suitable drinking water available to a household, even if the water is obtained from an improved source. Water that must be fetched from a source that is not immediately accessible to the household may become contaminated during transport or storage. Especially in such situations, home water treatment can be effective in improving the quality of household drinking water.

According to the Nigerian Demographic Household Survey, 2013, some 61% of the households in Nigeria have access to an improved source of drinking water, with a much higher proportion among urban households (76%) than among rural households (49%). The results show an overall improvement in the quality of sources of water in Nigeria since the 2008 NDHS (when the figure was 56%). This improvement was higher in rural areas (45-49%) than in urban areas (75-76%). The most common source of improved drinking water in Nigeria is tube well or borehole water, used by 44% of urban and 32% of rural households. Thirteen percent of urban households and 10% of rural households have access to drinking water from a protected well. Use of sachet water, which is included under non-improved sources, is common in Nigeria, with 6 percent of households using it as their main source of drinking water. It is used more in urban areas than in rural areas (12% versus 1%). In the 2013 NDHS, only 20% of households reported having water on their premises, as compared with 25% in the 2008 NDHS. Households not having water on their premises were asked how long it takes to fetch water. About a quarter of households (24%) travel 30 minutes or longer to obtain their drinking water (20% in urban areas and 28% in rural areas).

In the 2013 NDHS, all households also were asked whether they treat their water prior to drinking. An overwhelming majority, 88%, do not treat their drinking water. Urban households (8%) are somewhat more likely than rural households (3%) to use an appropriate treatment method to ensure that their water is safe for drinking. The statistics indicates that many households in some of Nigeria's states have no access to improved source of drinking water. More than any other amenity, water facilities are present in most communities across the Niger Delta region but more often than not, water never flows from the facilities for the population (Ojile, 2010). The availability of social infrastructures in the proposed Rainoil Mini/500MT LNG Blending Plant stakeholder community, including those of potable drinking water presents a disproportionate access to potable water supplies for the resident population thus a challenge to human health and well-being. The community with functional water facilities have complaints of inadequate capacity for the population served. The stakeholder community has access to potable water supplies. The people also depend on private owned borehole and hand dug well.

**(ii) Access to sanitation facility**

About 15% of community's members do not have a toilet facility within the ideal 50m distance from their houses, even though most of the facilities were of pit toilet, and some excrete directly in the surrounding bush, a practice that often contaminate surface water, and are not technically considered a toilet facility. The use of these toilet facilities is really a threat to the community member's health as admitted by the respondents since it can contaminate the receiving water body with raw fRainoil Limited/Rainoil Gas Limitedes...like one of the respondents asked, 'what will they do', since some of the community members can't afford an ideal toilet facility in their individual household.

**(iii) Energy for cooking**

The use of firewood and charcoal was observed from some members of the community as a source of fuel for domestic cooking as well as the predominant method of roasting plantain (bole) and smoking of ice fish, which is preservation in the community notwithstanding the health implications.

**(iv) Waste management**

Waste generated in the study area was mainly garbage and other domestic wastes. These wastes were usually dumped near residential buildings at the backyard. These wastes can become a source of contamination of the water body yet this is what is commonly practiced in the communities.

**(v) Alcohol usage and cigarette smoking**

Smoking was common in the community; a significant number of the young males in the community are said to smoke cigarette...but an average smoker smoke at most three sticks of cigarette a day. Women in most of the community rarely smoke cigarette, but female smokers could be found in the community mostly at night smoking by the commercial sex workers.

**(vi) Sexual behaviour**

Sexual behaviour is directly related to the incidence of sexually transmissible infections and diseases, including HIV/AIDS. The two key behaviours useful in public health action are number of sexual partners and condom use. Majority at the proposed proposed Rainoil Mini/500MT LNG Blending Plant community members claimed to have only one sexual partner while a few admitted to having more than one. The uptake of condoms from the drug stores was used as proxy indicator to measure the behaviour of the people with regards to preventive measures relating to unwanted pregnancies and sexually transmitted infections. Condom uptake was relatively low.

The knowledge of the existence of HIV/AIDS is high in the community. The methods of STIs transmission (needles, razor blade and sexual contact) is also well known in the communities. The 2003 NDHS reported that 70.6% of female youths in the South-South reported having high risk (unprotected) sex in past one year (higher than the national averages of 29.4%). However, the HIV/AIDS Reproductive Health Survey showed figures for South West females and males to be 69.3% and 68.6% respectively (FMOH, Nigeria 2005). This shows a slight decline but is still higher than the National average of 67% for females and 63% for males from the same report.

This risky sexual behavior increases vulnerability to both STIs and HIV/AIDS. HIV sero-prevalence in Nigeria has not been increasing but the level is still worrisome. The factors that drive increase in HIV/AIDS prevalence such as industrialization, promiscuity; low condom use is prevalent in the study area. The high prevalence rate of HIV/AIDS in an area is sustained by several factors including; project-induced influx of workers who have a higher income level than locals, migration of commercial sex workers due to the economic attraction of workers, risky sexual behaviours, high sexual activities, early sexual exposures.

**(vii) Housing**

The provision of good housing is an important aspect of environmental health. It represents a significant part of man's environment; shelter from the elements; workshop (the kitchen for the housewife, the playroom for the children and tool-shed for the adult males); and home (the residence of the family), where this social institution carries out some of its major functions. Consequently, good housing should minimize physical and biological hazards in the environment, provide a good social environment and promote the health of the inhabitants.

The housing pattern, type and structure within any given community or communities and study area are more often than not, a reflection of the settlement pattern itself. As a consequence, the housing pattern, type and structure within the study area are a reflection of its generally and predominantly rural-urban environmental setting; old housing stocks are generally intermixed with emergent modern types. The bigger and more populated the community, the better the quality of housing stock with housing patterns depending on the status of a family/compound. Majority of the houses are of the rooming type, with modal walling and roofing materials being constructed of concrete block with corrugated iron sheets (zinc/aluminium) for roofing. A sizeable proportion of the housing stock are also of the wattle and daub (mud-wall) type, some of which have been rendered (plastered with cement) and have both corrugated iron zinc and thatched roofing. Going by responses from administered questionnaires, one could conclude that housing type and quality are generally fine and good.

The quality of housing in the community measured by the walling, flooring and roofing materials used indicates that majority of the respondents (72.4%) live in houses constructed of concrete block or cement walls and with zinc roofing. On average, 22.3% of the respondents live in houses constructed of mud wall with corrugated iron roofing sheets (zinc) and mud with thatch roofing accounting for 0%. Smaller fractions (1.7%) of the population live in varied other types of housing in the area.

The availability of durable consumer goods is a good Indicator of 208elieve208dd's socioeconomic status. Furthermore, particular goods have specific benefits. For example, having access to a radio or a television exposes household members to innovative ideas; a refrigerator prolongs food storage; and a means of transport allows greater access to many services away from the local area. As a measure of the overall quality of life apart from incomes and available community-wide basic infrastructures, the proportion of the population with or without the requisite amenities in their dwellings should indicate either a satisfactory situation or otherwise. Valid responses could however, not be gleaned from retrieved questionnaires. Generally, many households could own basic household amenities like telephone (mobile/GSM), electric fan, radio, television and generator especially where facilities to enjoy the amenities, e.g. electricity is readily available. Householders in bigger urban areas are more likely to own household goods than their rural counterparts.

**(viii) Knowledge of HIV/AIDS**

Most respondents during the focus group discussion in the community have heard of HIV/AIDS but knowing how it’s usually contacted was observed to be very low. There is need to carry out awareness campaign to educate members of the communities on HIV/AIDS. And most recent is the deadly coronavirus codenamed Covid-19, although this is being widely publicized worldwide but few still claim ignorance of it. There is a need to keep educating the public on the preventive measure of these deadly diseases.

**(ix) Household Food**

Common foods eating in the study area include garri, plantain, loiloi, rice, and yam. Others eaten at lesser levels include fish, vegetables, beans, milk, eggs and meat. Malnutrition is a major health problem in Nigeria and provides an overall picture of the health status of the population. Children who are malnourished are at a greater risk of falling sick and dying than children who are not malnourished.

Three standard indices of child growth are used to describe nutritional status, Height-For-Age (stunting), Weight-For-Height (wasting) and Weight-For-Age (underweight). To ensure that the results obtained in this study are comparable on an international scale, they are expressed in terms of Z scores. The Z score gives indication in units of standard deviation how far from the reference value a given value lies. The standard used here is based on the National Canter for Health Statistics (NCHS) growth references as recommended by the World Health Organisation (WHO).

An assessment of the nutritional status of 195 children in the surveyed community, aged 0-5 years, was carried out Table 4. The indices of malnutrition recorded showed that 26.7% were underweight, 32% were stunted and 13.4% were wasted (**Table 4.18**). A child with a significantly low height-for-age ratio is considered to be stunted or short for his age. This is generally the result of a failure to receive adequate nutrition over an extended period of time and is also affected by recurrent episodes of chronic illness. Children whose Weight-For-Height (W/H) ratio is significantly low are defined as wasted or thin for their age. One in ten surveyed children was classed as wasted. Stunting and wasting are both most severe in the second year of life. This pattern is likely to be due to poor weaning diets (with breast milk offering significant protection in the first year) and infected sources of water resulting in acute illnesses from diarrhoea mainly in the second, third and fourth years of life.

**Table 4.18: Weight and height for age of pre-school children in the studied community**

| **Age (months)** | **Mean Weight (kg)** | **Mean Height (m)** | **Weight for age (Normal range) kg** |
|---|---|---|---|
| 0 – 11 | 6.73 | 0.54 | 3.5 – 9.4 |
| 12 – 23 | 9.17 | 0.76 | 9.5 – 12.4 |
| 24 – 35 | 11.45 | 0.91 | 12.5 – 14.4 |
| 36 – 47 | 12.60 | 0.94 | 14.5 – 17.4 |
| 48 – 60 | 13.98 | 1.02 | 17.5 – 19.4 |

**(x) Mortality Rate**

The mortality figures from questionnaire survey are grossly unreliable. The indigenes tend to give exaggerated values when asked about mortality cases may be to lend credence for their demand for more government presence. Inadequate records on mortality rates from the local government level where cases of death are supposed to be registered were also noted. The common causes of mortality in the project area especially in children includes; diarrhoea, malnutrition, malaria, respiratory tract infections, and measles as well as other vaccine preventable diseases. These illnesses were prevalent in the area from the hospital record.

**(xi) Morbidity Rate**

Mortality rates between the ages of 0-5 and maternal mortality rates are said to be low in proposed Rainoil Mini/500MT LNG Blending Plant community. This was observed during the focus group discussion with the community. It was said that women dies during pregnancy and childbirth, and that this doesn't happen often but at most once in five years in the communities. The causes of the maternal death that happened in the community in the last five years according to the respondents are attributed to prolonged labour, and abortion.

**(xii) Health system**

The resident population in the proposed project community have access to functional primary health care services and general hospital. Functional and effective public (government health care facilities) primary healthcare (PHC) facilities and services are available in the community (**Plate 4.13**). The people go for their health care at the community government general hospital and FMC, Asaba as the case may be.

**Plate 4.13: General hospital in proposed Rainoil Mini/500MT LNG Blending Plant stakeholder community**

**(xiii) Traditional and Herbal Medicine Practices**

Traditional medical practice is available in the community. Their practice commonly involved the use of herbs derived from medicinal plants. Several medicinal plants abound in the area. Some of the medicinal plants used in the traditional medical practice in this study area and their uses are given in **Table 4.19**.

**Table 4.19: Common Medicinal Plants and their Uses in the Area**

| Common/local names | Botanical Names | Medicinal Uses |
|---|---|---|
| Pawpaw leaves | Carica papaya | Treatment of malaria |
| Alligator pepper plant | Afromomum melegueta | Galactogogue, purgative, sore throat, malaria, used by herbalists for consulting their oracles |
| Lemon orange | Citrus aurantium | Abdominal upset, and as a base for other herbs in treatment of malaria |
| Cashew fruit, leaf and bark | Anarcadium occidentale | Treatment of diarrhoea and menstrual problems |
| Mango leaves and bark | Mangifera indica | Treatment of malaria |
| Banana plant | Musa spp | Treatment of fever |
| Guava tree leaves and bark | Psidium guajava | Treatment of malaria, diarrhoea and menstrual disorders |

### 4.10.20.1: Community Expectations and Suggestions to Mitigate & Enhance Socioeconomic Impacts

Community consultation, focus group discussion (FGD) and responses from the administered questionnaires indicated that the resident populations are not in any way against the proposed Rainoil Mini/500MT LNG Blending Plant project and its operations in the affected community. The fulfillment of promises and terms as may contained in GmoU when entered into is regarded as very vital in improving the company’s relations with the stakeholders’ community. However, the various group in the community (the elderly group, women group and youth group) expectations/needs are numerous but prominent among them are; provision of employment opportunities, skill acquisition/technical training, soft loan/grant for the women, scholarship for the children and ward etc. However, the people enjoin Rainoil on her commitment to the discharge of their corporate social responsibilities by the time operation starts.

The provision of infrastructural, employment of indigene, and importantly transparency in dealing with the community ranks very high among the expectations of the community members. It is important to point out here that, one of the causes of the crises that affected the whole Niger Delta Region was attributed to unemployment; although unemployment is a global thing. Others are youth delinquency, land dispute, chieftaincy tussle, inter-family problem, inter-village conflict, unemployment and alcoholism/prostitution. Youth delinquency and unemployment are identified to be higher among the social problems in the area with 35.7% and 18.7% respectively. Also, 2.5% (land dispute), 20.4% (alcoholism/prostitution), 6.4% (chieftaincy tussle), 3.7% (inter-family problem), and 12.6% (inter-village conflict) (see **Figure 4.28**).

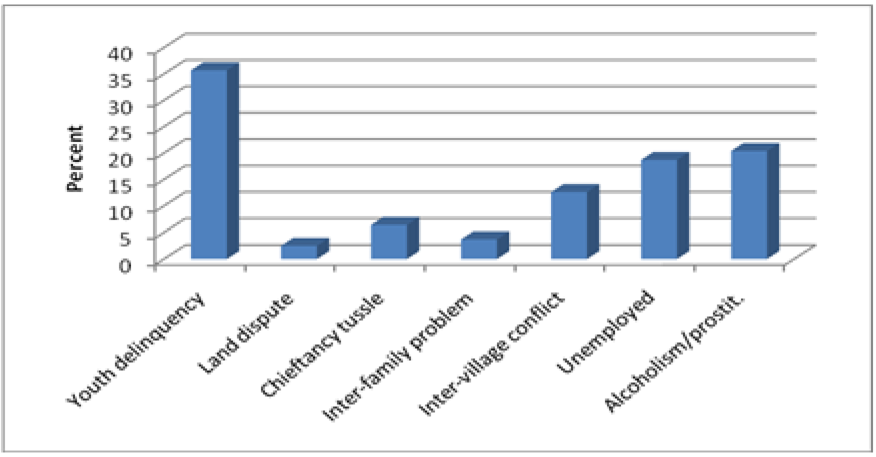



**Figure 4.28: Social problems**

Some of the recommendations by the community members to mitigate against some of these social problems are obvious…emphasis was particularly on the need to employ proposed project affected community members who are qualified and are ready to work, provision of vocational/technical training for the youth, and award of scholarship. Most importantly, transparency in dealing with proposed project stakeholder community is greatly recommended. It213elieveed that these items if provided could go a long way in mitigating the identified social problems as well as helps the company (Rainoil Limited) to have a smooth operation in the area.

# CHAPTER FIVE

# POTENTIAL ENVIRONMENTAL IMPACTS

## 5.1 Introduction

There are a number of approaches for the prediction and evaluation of impacts. The ISO 14001 method is simple to apply and provides a high level of detail and also relies on limited data, unlike the other methods that require the availability of large historical data. The ISO 14001 method, is therefore selected for the identification and evaluation of impacts for this proposed 500MT LPG Blending Plant project at Ibusa, Oshimil North LGA, Delta State, Nigeria.

## 5.2 Impact Identification and Evaluation

In line with general guidelines for an Environmental Impact Assessment (EIA) process, the following were the basic steps adopted for identification and evaluation of impacts:

- ✓ Impact identification
- ✓ Impact qualification
- ✓ Impact rating
- ✓ Impact description

### 5.2.1 Impact Identification

The aim of impact identification is to account for the entire potential and associated bio-physical, social and health impacts making sure that both significant and insignificant impacts are accounted for. The anticipated impacts were determined based on the interaction between project activities and environmental sensitivities. The identified potential impacts during the different phases of the proposed 500MT LPG Blending Plant project are listed in **Table 5.1**.

### 5.2.2 Impact Qualification

The identified impacts of the project were qualified based on the following four criteria:

- Positive or negative
- Short-term or long-term
- Reversible or irreversible
- Direct or indirect

Positive impacts are those which enhance the biophysical, health, and social environment while the negative impacts adversely affect the biophysical, health, and social environments. However, for this study, short term means a period of time less than three months while any period greater than three months is considered long term. Reversible/irreversible mean whether the environment can either revert to previous conditions or remain permanent when the activities causing the impact is terminated.

**Table 5.1: Identified Project Impacts of Proposed 500MT LPG Blending Plant Project at Ibusa**

| Impacts | Phase | | |
|---|---|---|---|
| | **Pre- Construction** | **Construction** | **Decommissioning /Abandonment** |
| Acceleration of erosion | √ | √ | |
| Acidification of soil and groundwater | | √ | |
| Alteration of local hydrology and drainage patterns | | √ | |
| Alteration of local topography | | | |
| Alteration of natural drainage pattern | √ | √ | |
| Alteration of soil profile | | √ | |
| Availability of fuel wood | √ | | |
| Blockage of waterways | | √ | |
| Change in local topography | | √ | |
| Contamination of groundwater | √ | √ | √ |
| Contamination of surface water/soil and sediment | √ | √ | √ |
| Exposure of workers to wildlife attack | √ | √ | √ |
| Impairment of air quality | √ | √ | √ |
| Increase in incidence of STI’s including HIV | √ | √ | √ |
| Increase in social vices | √ | √ | √ |
| Increased opportunity for business and employment | √ | √ | √ |
| Influx of migrant workers and camp-followers | √ | √ | √ |
| Injuries and death from blowouts | √ | √ | √ |
| Legacy issues | √ | | |
| Light trespass and sky glow | | | |
| Loss of biodiversity | √ | √ | √ |
| Loss of employment/income | | | √ |
| Noise and vibration nuisance | √ | √ | √ |
| Opportunities for business and employment | √ | √ | √ |
| Pirate attacks and kidnappings | √ | √ | √ |
| Pollution from drill cuttings and mud | | | |
| Reduction of access to land and its resources | √ | | |
| Third party agitations | √ | √ | √ |
| Visual obstruction | | √ | |
| Land and water traffic accidents | √ | √ | √ |
| Work site accidents | √ | √ | √ |

### 5.2.3 Impact Rating

This stage involves evaluation of the impact to determine whether or not it is significant. The quantification scale of 0, 1, 3 and 5 was used. The ratings are as described below and are adapted from The International Organization for Standardization ISO 14001– Environmental Management System Approach. The criteria and weighting scale used in evaluating significance are as follows:

- Legal/regulatory requirements (L)
- Risk factor I
- Frequency of occurrence of impact (F)
- Importance of impact on an affected environmental components (I), and
- Public perception/interest (P).

#### 5.2.3.1 Legal /Regulatory Requirements (L)

This asks the question 'is there a legal/regulatory requirement or a permit required?' The scoring is as follows:

0= There is no legal/regulatory requirement

3= There is legal/regulatory requirement

5= There is a legal/regulatory requirement and permit required

The legal/regulatory requirements were identified based on national laws/guidelines/standards (NMDPRA and FMEnv) relating to the project activity.

#### 5.2.3.2 Risk I

This uses a matrix based on the interaction of the probability of occurrence of the impact (**Table 5.2**) against consequences (**Table 5.3**). The matrix (**Figure 5.1**) is referred to as the Risk Assessment Matrix (RAM). Five probability categories are interacted against four groups of consequences. The resultant outcomes are given scores with colour-coding. High-risk categories are red; intermediate risks, yellow and low risks, green as follows:

1=Low risk (green)

3=Intermediate risk (yellow)

5=High risk (red)

**Table 5.2: Probability of Occurrence**

| Probability Category | Definition |
|---|---|
| A | Possibility of Repeated Incidents |
| B | Possibility of Isolated Incidents |
| C | Possibility of Occurring Sometime |
| D | Not Likely to Occur |
| E | Practically Impossible |

**Table 5.3: Consequence Categories**

| Consequence Category | Considerations | | | |
|---|---|---|---|---|
| | Safety / Health | Public Disruption | Environmental Aspects | Financial Implications |
| I | Fatalities / Serious Impact on Public | Large Community | Major/Extended Duration/Full Scale Response | High |
| II | Serious Injury to Personnel/Limited Impact on Public | Small Community | Serious/Significant Resource Commitment | Medium |
| III | Medical Treatment for Personnel/No Impact on Public | Minor | Moderate/Limited Response of Short Duration | Low |
| IV | Minor Impact on Personnel | Minimal to None | Minor/Little or No Response Needed | None |

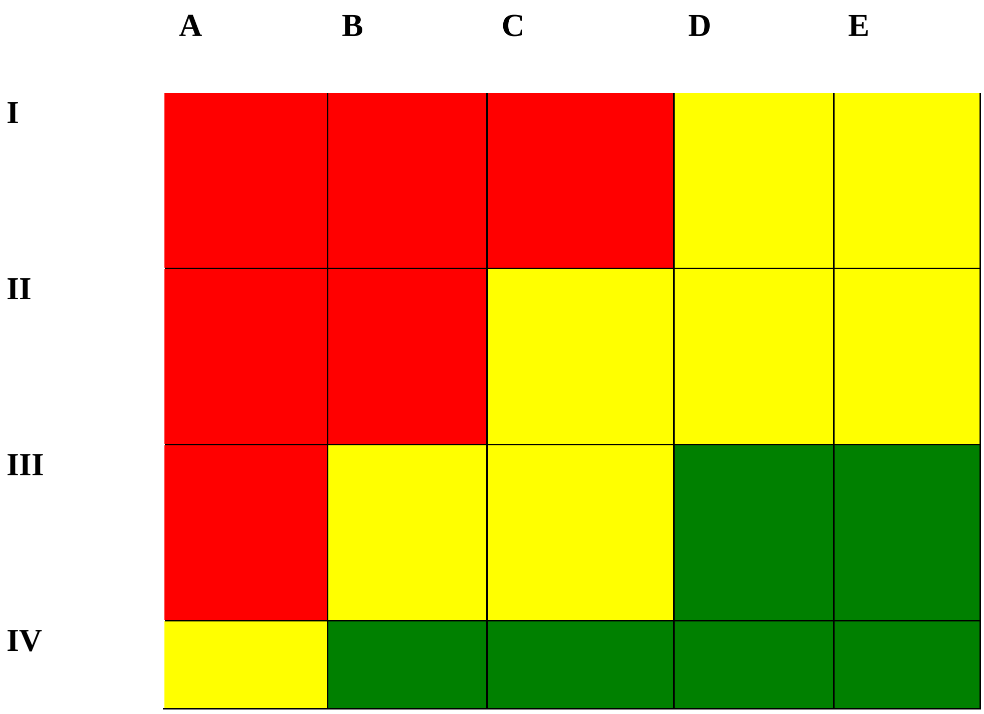



**Figure 5.1: Risk Assessment Matrix**

### 5.2.3.3 Frequency of Impact (F)

Frequency of impact refers to the number of occurrence of impacts. The frequency of impact was determined using historical records of occurrence of impacts, and consultation with experts and local communities. The criteria for rating the frequency of impacts are outlined in Table 5.4.

**Table 5.4: Frequency Rating and Criteria**

| Frequency | Rating | Criteria |
|---|---|---|
| Low | 1 | Rare, not likely to happen within project lifespan |
| Medium | 3 | Likely to happen ≥ 5 years |
| High | 5 | Very likely to happen throughout the project lifespan |

### 5.2.3.4 Importance of Affected Environmental Component and Impact (I)

The importance of the affected environmental components was determined through consultation and consensus of opinions. This was also further facilitated by information on experiences on the impacts of already existing similar facilities. The rating of the importance of impacts is shown in **Table 5.5**.

**Table 5.5: Importance Criteria**

| Importance | Rating | Criteria |
|---|---|---|
| Low | 1 | • Imperceptible outcome<br>• Insignificant alteration in value, function or service of impacted resource<br>• Within compliance, no controls required |
| Medium | 3 | • Negative outcome<br>• Measurable reduction or disruption in value, function or service of impacted resource<br>• Potential for non-compliance |
| High | 5 | • Highly undesirable outcome (e.g., impairment of endangered species and protected habitat)<br>• Detrimental, extended animal behavioural change (breeding, spawning, moulting)<br>• Major reduction or disruption in value, function or service of impacted valued ecosystem resource<br>• Impact during environmentally sensitive period<br>• Continuous non-compliance with existing statutes |

#### 5.2.3.5 Public Perception (P)

The consensus of opinions among the project stakeholders were used to determine the public perception on the potential impacts and the following criteria were applied (**Table 5.6**). The combination of the five impact rating weights forms the basis for judging the level of significance of each impact. A matrix displaying the combination based on the ISO 14001 tool is shown in **Figure 5.1**. The final ratings of the existing and identified impacts are presented in **Tables 5.7 – 5.9**. In this report, medium and high significant negative impacts were judged to require mitigation, and all positive impacts required enhancement.

**Table 5.6: Public Perception Criteria**

| Public Perception | Rating | Criteria |
|---|---|---|
| Low | 1 | • No risk to human health, acute and/or chronic<br>• No possibility of life endangerment for residents, associated communities<br>• Minor reduction in social, cultural, economic values<br>• Unlikely adverse perception among population |
| Medium | 3 | • Limited incremental risk to human health, acute and/or chronic<br>• Unlikely life endangerment for residents, abutting communities<br>• Some reduction in social, cultural, economic value<br>• Possibility of adverse perception among population.<br>• Potential for non-compliance |
| High | 5 | • Elevated incremental risk to human health, acute and/or chronic<br>• Possibility of life endangerment to residents, abutting communities<br>• Major reduction in social, cultural, economic value<br>• Continuous non-compliance with statute<br>• Any major public concern among population in study area |

<table>
<tr><th>Impact value</th><th>Cut off values</th><th>Impact Rating</th></tr>
<tr><td>L+R+F+I+P</td><td><8</td><td>Low</td></tr>
<tr><td>L+R+F+I+P</td><td>≥8 but <15</td><td>Medium</td></tr>
<tr><td>L+R+F+I+P</td><td>≥15</td><td rowspan="3">High</td></tr>
<tr><td>F + I</td><td>>6</td></tr>
<tr><td>P</td><td>= 5</td></tr>
<tr><td colspan="2">Positive</td><td>Positive</td></tr>
</table>

**Figure 5.2: Impact Value and Rating Colour Code**

**Table 5.7: Potential and Associated Impacts of the Proposed 500MT LPG Blending Plant Project at Ibusa (Pre-Operational Phase)**

| Project Activity | Description of Impact | Impact Qualification | | | | | | | | Impact Quantification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Positive | Negative | Direct | Indirect | Short term | Long term | Reversible | Irreversible | L | R | F | I | P | Total | F+I | Impact Rating |
| **Land acquisition and survey** | Exposure of workers to wildlife attack | | √ | √ | | | √ | √ | √ | 0 | 5 | 1 | 1 | 1 | 9 | 2 | M |
| | Legacy issues | | √ | | √ | | √ | √ | | 3 | 5 | 5 | 5 | 5 | 23 | 10 | H |
| | Opportunity for income generation | √ | | | √ | √ | | √ | | - | - | - | - | - | - | - | P |
| | Reduction of access to land and its resources | | √ | √ | | | √ | √ | | 3 | 5 | 3 | 3 | 5 | 19 | 6 | H |
| | Third party agitations | | √ | | √ | | √ | √ | | 3 | 5 | 5 | 5 | 5 | 23 | 10 | H |
| | | | | | | | | | | | | | | | | | |
| **Mobilization of equipment& personnel to site** | Impairment of air quality from emission of air pollutants including greenhouse gases | | √ | √ | | √ | | √ | | 3 | 1 | 1 | 5 | 5 | 15 | 6 | H |
| | Increase in incidence of STI's including HIV | | √ | | √ | √ | √ | √ | √ | 0 | 3 | 3 | 5 | 5 | 16 | 8 | H |
| | Increase in noise and vibration/levels | | √ | √ | | | √ | √ | | 3 | 1 | 3 | 1 | 3 | 11 | 4 | M |
| | Interference with land and water transport | | √ | √ | | √ | | √ | | 5 | 3 | 1 | 1 | 3 | 13 | 2 | M |
| | Pirate attacks and kidnappings | | √ | | √ | √ | √ | √ | √ | 3 | 5 | 3 | 5 | 5 | 21 | 8 | H |
| | Land traffic accidents | | √ | √ | | √ | √ | √ | √ | 3 | 5 | 3 | 5 | 5 | 21 | 8 | H |
| | | | | | | | | | | | | | | | | | |
| **Site** | Acceleration of erosion | | √ | √ | | | √ | | √ | 0 | 1 | 1 | 1 | 1 | 4 | 2 | L |

| Project Activity | Description of Impact | Impact Qualification | | | | | | | | Impact Quantification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Positive | Negative | Direct | Indirect | Short term | Long term | Reversible | Irreversible | L | R | F | I | P | Total | F+I | Impact Rating |
| **Preparation (Vegetation clearing)** | Availability of fuelwood | √ | | √ | | √ | | √ | | - | - | - | - | - | - | | P |
| | Exposure of workers to wildlife attack | | √ | √ | | √ | | √ | | 3 | 5 | 1 | 3 | 3 | 15 | 4 | H |
| | Habitat Fragmentation | | √ | √ | | √ | | √ | | 0 | 3 | 3 | 1 | 1 | 8 | 4 | L |
| | Impairment of air quality by emission of air pollutants including greenhouse gases | | √ | √ | | √ | | √ | | 3 | 1 | 3 | 3 | 3 | 13 | 6 | M |
| | Increase in access for poaching and illegal lumbering | | √ | √ | | | √ | | √ | 0 | 1 | 1 | 3 | 1 | 6 | 4 | L |
| | Increase in social vices | | √ | | √ | | √ | √ | √ | 3 | 3 | 3 | 3 | 5 | 17 | 6 | H |
| | Increased opportunity for business and employment | √ | | √ | | √ | | √ | | - | - | - | - | - | - | | P |
| | Influx of migrant workers and camp-followers pressure on existing infrastructure | | √ | √ | | √ | | √ | | 0 | 3 | 3 | 1 | 1 | 8 | 4 | M |
| | Loss of biodiversity | | √ | √ | | | √ | √ | | 3 | 1 | 3 | 1 | 1 | 9 | 4 | M |
| | Work site accidents | | √ | √ | | √ | √ | √ | √ | 3 | 5 | 1 | 3 | 3 | 15 | 4 | H |
| | | | | | | | | | | | | | | | | | |
| **Movement of construction equipment to Site** | Impairment of air quality by emission of air pollutants including greenhouse gases | | √ | √ | | √ | | √ | | 3 | 1 | 1 | 1 | 1 | 7 | 2 | L |
| | Increase in noise and vibration levels | | √ | √ | | √ | | √ | | 3 | 1 | 1 | 1 | 1 | 7 | 2 | L |
| | Interference with land | | √ | √ | | √ | | √ | | 5 | 3 | 3 | 3 | 3 | 17 | 6 | H |

| **Project Activity** | **Description of Impact** | **Impact Qualification** | | | | | | | | **Impact Quantification** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Positive | Negative | Direct | Indirect | Short term | Long term | Reversible | Irreversible | L | R | F | I | P | Total | F+I | Impact Rating |
| | transportation | | | | | | | | | | | | | | | | |
| | Pirate attacks and kidnappings | | √ | | √ | √ | √ | | √ | 0 | 5 | 3 | 5 | 5 | 18 | 8 | H |
| | | | | | | | | | | | | | | | | | |
| **Site Construction Equipment / Facility Set-Up** | Impairment of air quality by emission of air pollutants including greenhouse gases | | √ | √ | | √ | | √ | | 3 | 1 | 1 | 1 | 1 | 7 | 2 | L |
| | Noise and vibration nuisance | | √ | √ | | √ | | √ | | 3 | 1 | 3 | 1 | 3 | 11 | 4 | M |

**Table 5.8: Potential and Associated Impacts of the Proposed 500MT LPG Blending Plant Project at Ibusa (Operational phase)**

| Project Activity | Description of Impact | Impact Qualification | | | | | | | | Impact Quantification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Positive | Negative | Direct | Indirect | Short term | Long term | Reversible | Irreversible | L | R | F | I | P | Total | F+I | Impact Rating |
| **OPERATION AND MAINTENANCE** | Increase in concentrations of $NO_x$ and $SO_x$ in the air due to incomplete combustion from power generating plant, heavy machinery, and vehicular activities | | √ | √ | | | √ | √ | | 3 | 3 | 5 | 3 | 5 | 19 | 8 | H |
| | Increase in particulate matter concentration in the air due to incomplete combustion from power generating plant, heavy machinery, and vehicular activities | | √ | √ | | | √ | √ | | 3 | 3 | 3 | 3 | 3 | 15 | 6 | H |
| | Increased levels of heavy metals in plant tissues. | | √ | √ | | | √ | | √ | 0 | 3 | 3 | 5 | 3 | 14 | 8 | H |
| | Decrease in wildlife as a result of increased hunting and habitat loss | | √ | √ | | | √ | √ | | 3 | 3 | 3 | 5 | 3 | 18 | 8 | H |
| | Increased access to forest resources as a result of channelization and pipeline right of way (RoW), leading to deforestation | | √ | √ | | | √ | | √ | 3 | 3 | 3 | 5 | 3 | 18 | 8 | H |
| | Nominal increase in income of members of the community as a result of employment generating activities from the 500MT | √ | | √ | | | √ | √ | | | | | | | | | P |

| Project Activity | Description of Impact | Impact Qualification | | | | | | | | Impact Quantification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Positive | Negative | Direct | Indirect | Short term | Long term | Reversible | Irreversible | L | R | F | I | P | Total | F+I | Impact Rating |
| | Blending Plant activities | | | | | | | | | | | | | | | | |
| | Decrease in access to potable water as a result of communal crises | | √ | | √ | √ | | √ | | 0 | 3 | 3 | 5 | 5 | 16 | 8 | H |
| | Increase in numbers and access to health facilities | √ | | √ | | | √ | | √ | | | | | | | | P |
| | Decrease in child and maternal mortality | √ | | √ | | √ | | √ | | | | | | | | | P |
| | Increase in non-communicable diseases | | √ | | √ | | √ | √ | | 0 | 3 | 3 | 3 | 3 | 12 | 6 | M |
| | Increase in levels of alcohol and cigarette consumption | | √ | | √ | | √ | √ | | 0 | 3 | 5 | 3 | 3 | 14 | 6 | M |
| | Third party agitation | | √ | √ | | √ | | √ | | 3 | 1 | 1 | 5 | 5 | 15 | 6 | H |

**Table 5.9: Potential and Associated Impacts of the Proposed 500MT LPG Blending Plant Project at Ibusa (Decommissioning/Abandonment Phase)**

| Project Activity | Description of Impact | Impact Qualification | | | | | | | | Impact Quantification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Positive | Negative | Direct | Indirect | Short term | Long term | Reversible | Irreversible | L | R | F | I | P | Total | F+I | Impact Rating |
| **Dismantling of Equipment/facility and site clean-up** | Impairment of air quality by emissions of air pollutants including greenhouse gases | | √ | √ | | √ | | √ | | 3 | 3 | 1 | 1 | 3 | 11 | 2 | M |
| | Increase in noise and vibration level | | √ | √ | | √ | | √ | | 3 | 3 | 3 | 5 | 5 | 19 | 8 | H |
| | Increased opportunity for business and employment. | √ | | √ | | √ | | √ | | - | - | - | - | - | - | - | P |
| | Loss of employment/income | | √ | √ | | √ | | √ | | 3 | 1 | 5 | 5 | 5 | 19 | 10 | H |
| | Increased opportunity for business and employment. | √ | | √ | | √ | | √ | | - | - | - | - | - | - | - | P |
| | | | | | | | | | | | | | | | | | |
| **Movement of personnel and equipment out of site** | Impairment of air quality by emissions of air pollutants including greenhouse gases | | √ | √ | | √ | | √ | | 3 | 1 | 1 | 3 | 3 | 11 | 4 | M |
| | Increase in incidence of STI's including HIV | | √ | √ | | √ | | √ | | 0 | 3 | 3 | 5 | 5 | 16 | 8 | H |
| | Increased noise and vibration levels | | √ | √ | | √ | | √ | | 3 | 1 | 3 | 1 | 3 | 11 | 4 | M |
| | Pirate attacks and kidnappings | | √ | | √ | √ | √ | | √ | 0 | 5 | 3 | 5 | 5 | 18 | 8 | H |

| Project Activity | Description of Impact | Impact Qualification | | | | | | | | Impact Quantification | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Positive | Negative | Direct | Indirect | Short term | Long term | Reversible | Irreversible | L | R | F | I | P | Total | F+I | Impact Rating |
| | Increased noise and vibration levels | | √ | √ | | √ | | √ | | 3 | 1 | 3 | 1 | 3 | 11 | 4 | M |
| | Land traffic accidents | | √ | √ | | √ | √ | √ | √ | 3 | 5 | 3 | 5 | 5 | 21 | 8 | H |
| | | | | | | | | | | | | | | | | | |
| **Rehabilitation of site** | Employment and income generating opportunities | √ | | √ | | √ | | √ | | - | - | - | - | - | - | - | P |
| | Restoration of aesthetic value of the environment | √ | | √ | | √ | | √ | | - | - | - | - | - | - | - | P |

### 5.3: Impact Discussion from Proposed Project Activities

The likely impacts of the proposed project on the biophysical and socio-cultural components in the study area are as follows:

**Land use:** Land aquisation for the 500MT LPG Blending Plant project will impact on land use. These activities involve significant land take, which would have otherwise have been used for settlement and agriculture. This impact will be most significant at the acquired area. The impact would be direct, irreversible and of long-term duration.

**Vegetation:** During vegetation clearing, trees, shrubs and herbs will be permanently removed. Habitats of some species of plant and animal wildlife will also be lost. These impacts will, however, be restricted to the acquired area. The impact would be direct and of long-term duration.

**Biodiversity:** The impact on plant biodiversity will be direct and adverse as species will be lost permanently as a result of site clearing. The impact will also be limited to the acquired area. The impact would be direct and of long-term duration.

**Soil:** Soil will be exposed to direct sunlight rays due to removal of vegetation. This may elicit erosion, high temperature and changes in soil moistures regimes. This will lead to changes in soil physical and chemical characteristics and subsequent death of soil organisms; promotion of run-off and may impact nearby water body. These impacts will be direct and long term but localized.

**Air Quality**: Heavy machinery used during pre-operational and operational phase in loading and offloading of equipment, construction materials, and petroleum products may serve as mobile sources of noxious gases that could lead to atmospheric pollution. Some of these air pollutants are carbon monoxide (CO), nitrogen dioxide ($NO_2$), particulate matter (PM), and sulphur dioxide ($SO_2$). These pollutants, which are air toxics are known to degrade air quality. The particulate matters that would be released into the air could reduce visibility. The particles may settle on the surface of leaves thereby blocking the stomatal pores through which gaseous exchange occur during respiratory/photosynthetic activities. The impact would be direct, reversible and of short term duration.

**Increase noise level/vibration:** The noise during the various project phase may come mainly from power generating plants, heavy machinery/vehicular activities, loading and offloading processes. This combined effect will likely lead to annoyance and irritation. Also, the noise and vibration could adversely affect the noise sensitive animals. This will have some short term impact on people living within the project area.

**Socio-Economics:** The likely effects of the planned project and related activities on the communities and its total environment are enumerated below:

- **Demographic Changes**

The proposed project activities, which will involve movement of job seekers, could lead to a temporary net increase in population and moderately affect the demographic pattern. This impact is expected to be direct and indirect, reversible, of short-term duration and rated low.

- **Increase in social vices**

The job opportunities created by the project activities and the expected monetary gains could encourage some social vices such as drunkenness, violence and drug abuse. It could also attract commercial sex workers (CSW) and teenage girls to the area. The influx of these categories of people to the area has the potential to increase teenage pregnancies. The impact would be direct, irreversible/reversible, long-term, and rated high.

- **Pressure on existing infrastructure**

The relatively large labour force required for project activities could lead to an increase in overall population of the communities. Population increase due to the labour force and migrants could lead to overcrowding and its consequent pressure on existing housing, educational and recreational facilities. The impact would be direct, reversible, short-term, and rated medium.

- **Community Agitation**

Land acquisition, destruction of farmlands and other areas of interest and supply of labour could attract third party agitation involving inter- and intra-communal conflicts and human rights issues. The impact would be direct, reversible, short-term, and rated high.

- **Increase in cost of living/inflation**

The increase in population which is likely to occur as a result of the movement of people to the project site could overstretch available food supplies, healthcare and other social facilities such as housing, water and power supply. The shortage of these goods and services could result in increase in cost of living and attendant inflation. This impact would be direct, reversible, short-term, and rated medium.

- **Emergence of new communicable diseases**

The movement of a large number of people (workers and job) into the hitherto isolated, discrete communities could introduce new diseases in the communities if good hygiene is not ensured. This impact would be direct, reversible, of short-term duration and rated medium.

- **Sexually transmitted infections (STIs), skin and respiratory diseases**

There could be an increase in STIs (including HIV/AIDS), due to anticipated movement of commercial sex workers and increase in sexual risk behaviours. Skin and respiratory diseases could also occur from overcrowding and poor ventilation (poor housing conditions) due to anticipated marginal increase in population. This impact would be direct, irreversible, of long-term duration and rated high.

- **Soft tissue injury and poisoning**

There could be an increase in soft tissue injuries and poisoning from exposure of field workers and community members to poisonous plants and dangerous animals (snakes, bees, etc.) that have been displaced from their habitats. This impact would be direct, reversible, of short-term duration and rated medium.

- **Trauma and deaths**

This could result from work-related/road accidents involving field workers/road users. This impact would be direct, irreversible, of long-term duration and rated high.

- **Respiratory disorders**

Gaseous discharges and dust particles from vegetation clearing, excavation and heavy machinery/vehicles used during construction, could impair lung functions could lead to or aggravate respiratory disorders such as bronchitis and asthma. This impact would be direct, irreversible, of long-term duration and rated high.

- **Improvement in Local Economy**

Positively, the proposed project is expected to benefit the local economy of the host community (Ibusa) employment opportunities, the opportunities for contract works and welfare improvements in the host community. All these are capable of having a beneficial multiplier effect on the local economy.

# CHAPTER SIX

# MITIGATION MEASURES

## 6.1 Introduction

The actions and measures that Rainoil Limited/Rainoil Gas Limited intends to take to reduce (or eliminate) negative impact and promote positive Environmental, Social and Health impacts of the existing and proposed Project are presented in this chapter. In these mitigation measures, emphases are placed on those negative impacts rated as significant. These measures are aimed at reducing these impacts to As Low As Reasonably Practicable (ALARP). The residual impacts that could arise despite these mitigation measures were also noted. Significant negative impacts are expected to be mitigated through effective implementation of Health, Safety Security Social and Environment (HSSSE) policies put in place during the different phases of the project.

The mitigation measures proposed are in consonance with the following:

- Department of Petroleum Resources (DPR) under the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) guidelines and standards
- Environmental laws at national, regional and internal levels
- FMEnv (formerly FEPA, 1991) regulations on oil and gas exploration and waste management.
- Delta State Ministry of Environment policies;
- Best Available Technology for Sustainable Development;
- Social wellbeing; and
- Concerns of stakeholders.

## 6.2 Approaches to Impact Mitigation Measures

The selected approaches include enhancement (for the positive impacts), prevention, reduction, avoidance and compensation (for the significant negative impacts). Furthermore, the mitigation measures for each (significant and adverse) impact of the proposed project activities were generally identified, based on the associated effect to the environment and human health and safety. The significance of the impact, probability that the impact would occur and the severities of its consequence (as determined from the risk assessment matrix) were indices used for determining the mitigation requirements as illustrated in **Figure 6.1**. Subsequently, the specific mitigation measures satisfying the mitigation requirement were established putting into consideration available resources and competencies, on-site conditions, public concerns and technology.

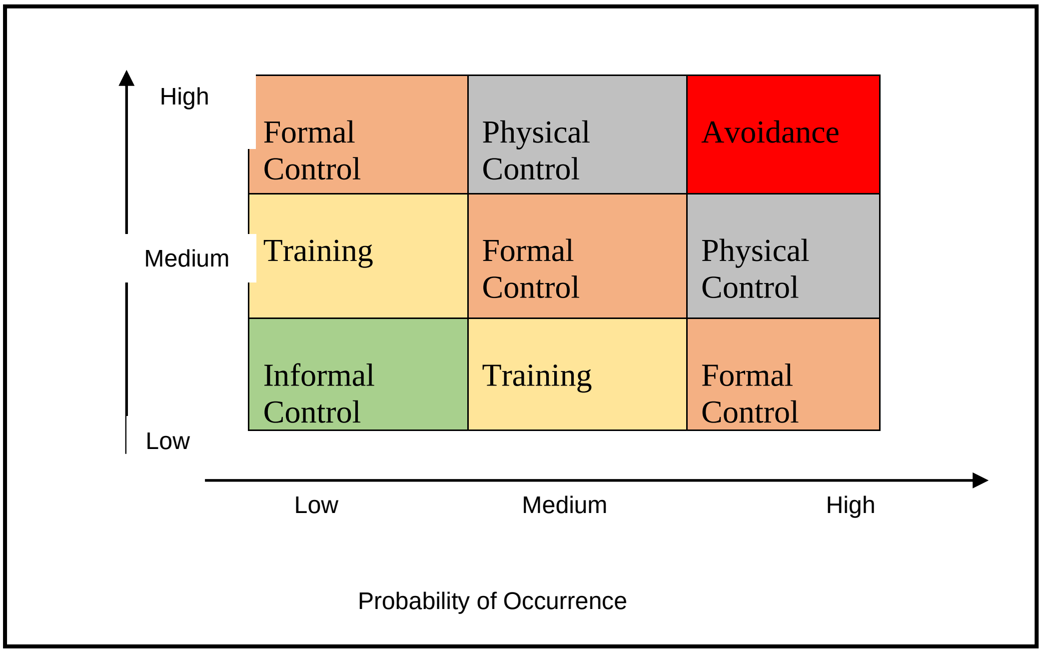



**Figure 6.1: Matrix for determination of mitigation measures**

The various approaches to impact mitigation considered are presented below.

**Enhancement:** These are measures proffered to ensure that significant beneficial impacts of the existing facilities and proposed project are encouraged.

**Prevention:** These are measures proffered to ensure that significant and adverse potential impacts and risks do not occur.

**Reduction:** These are measures proffered to ensure that the effects or consequences of those significant associated and potential impacts that cannot be prevented are reduced to a level as low as reasonably practicable.

**Formal control:** This involves the application of documented policy, process or procedure in mitigating the impacts of the project activities.

**Informal Control:** This involves the application of sound judgment and best practice in mitigating the impacts of project activities.

**Physical control:** This involves the physical application of physical processes or instruments (such as sign post/caution signs, flags, pegs, etc.), which may not necessarily require any special technology, in order to mitigate the impacts of a project or impacts.

**Avoidance:** This involves the modification of plans, designs or schedules in order to prevent the occurrence of an impact.

**Training:** This involves personnel awareness in specific or specialized areas of operation.

### 6.3 Management Procedure for Mitigation Measures

The management procedures employed for the establishment of mitigation measures for the identified impacts is presented in **Figure 6.2**. Mitigation measures were subsequently proffered for adverse significant potential impacts. These measures (prevention, reduction, control strategies) were developed for the adverse impacts through review of industry experience (past project experience), consultations and expert discussions with multi-disciplinary team of engineers and scientists.

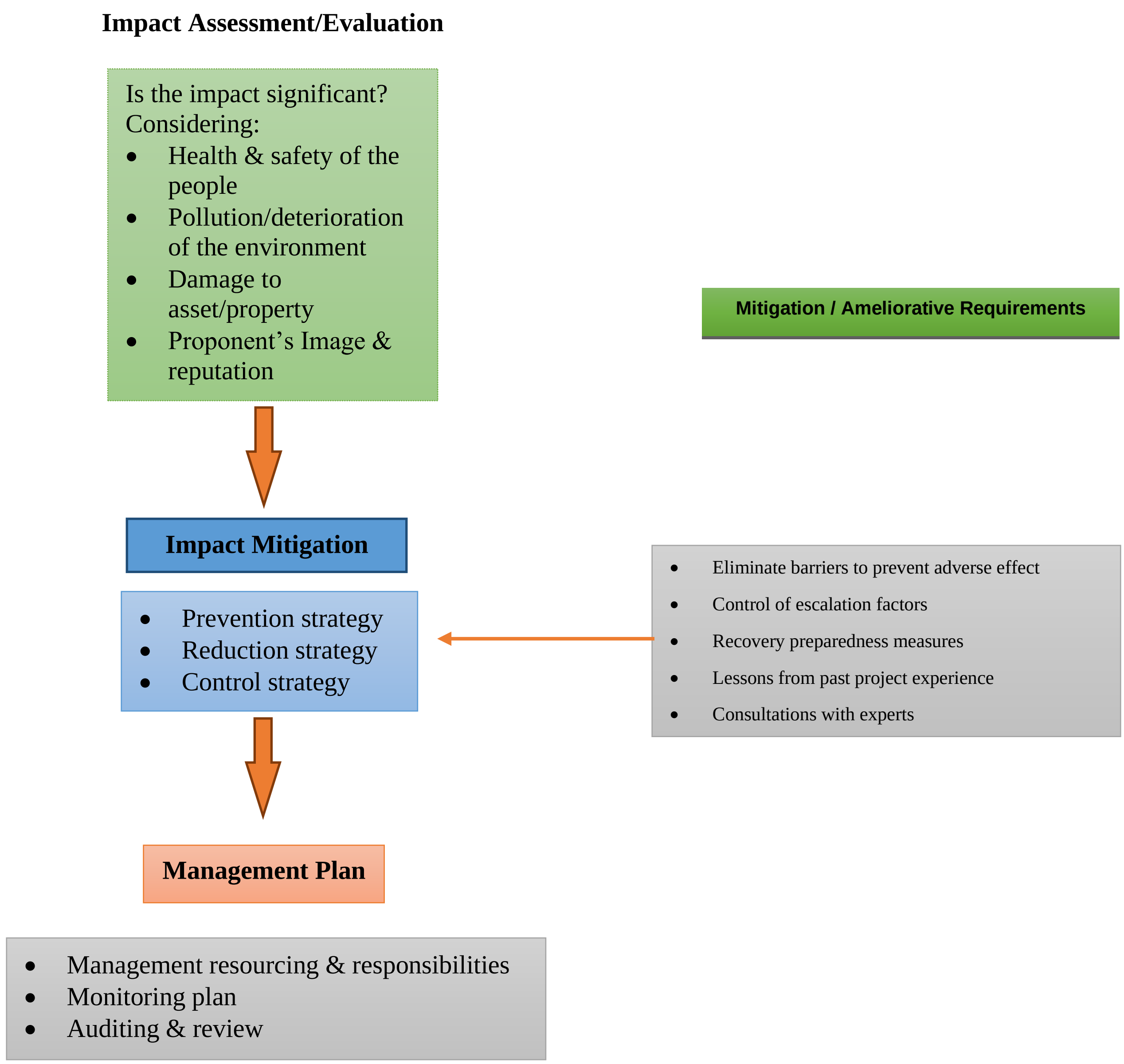



**Figure 6.2: Management Procedure for Mitigation Measures**

## 6.4 Proffered Mitigation Measures

This section presents the mitigation measures proffered for the significant (medium and high) adverse impacts of the proposed development projects. These cost-effective measures have been proffered with reference to best industry practice and HSSSE considerations.

Based on the impact assessment matrix in the previous section, the overall ratings of impact significance **High** or **Medium** or **Low** was established for each identified impact. The proffered mitigation measures and the expected final residual impact rating for the identified potential significant impacts are presented in the **Table 6.1.**

**Table 6.1: Impact Mitigation Measures for Proposed 500MT LPG Blending Plant Project at Ibusa (Pre-Operational Phase)**

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation |
|---|---|---|---|---|
| **Land acquisition and survey** | Exposure of workers to wildlife attack | M | • Rainoil Limited/Rainoil Gas Limited shall provide and enforce usage of PPE by field workers.<br>• Rainoil Limited/Rainoil Gas Limited shall provide First aid/Anti venom and insect repellant on site.<br>• Rainoil Limited/Rainoil Gas Limited shall create awareness among site workers and nearby communities on the likelihood of exposure to wildlife | L |
| | Legacy issues | H | • Rainoil Limited/Rainoil Gas Limited shall identify and settle all outstanding legacy issues within the project area | M |
| | Reduction of access to the acquired land and its resources | H | • Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• minimization of land take by following existing RoW<br>• thorough assessment of land requirements before additional land take<br>• Proper consultation to be carried out.<br>• appropriate compensation is paid for any additional land take<br>• Provision of alternative means of livelihood e.g. micro credit scheme. | L |
| | Third party agitation | H | • Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• management of public expectations by engaging NGOs and CBOs<br>• regular/periodic dialogue sessions with active NGOs and CBOs | M |

| **Project Activity** | **Description of Impact** | **Rating before mitigation** | **Mitigation measures** | **Rating after mitigation** |
|---|---|---|---|---|
| | | | • adoption of appropriate community entry strategies;<br>• Commitment to transparent adherence to G-MoU programmes and projects.<br>• improvement of company-media relation | |
| | | | | |
| **Movement of personnel and equipment to site** | Impairment of air quality by emissions of air pollutants including greenhouse gases | H | • Rainoil Limited/Rainoil Gas Limited shall use only pre-mobbed vehicles and boats<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that there is controlled use of all vessels and vehicles that their engines are turned off when not in use. | L |
| | Increase in incidence of STI's including HIV | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• regular medical check-ups are conducted for project work force<br>• condoms are provided for workers<br>• restriction of workers to the camp | M |
| | Increase in noise and vibration levels | M | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• regular maintenance of vessels and vehicles<br>• Vessels and vehicles are turned off when not in use<br>• Vessel and vehicles engines are fitted with effective silencers. | L |
| | Interference with land transportation | M | • Rainoil Limited/Rainoil Gas Limited shall minimize movement at the peak hours of water transportation<br>• RAINOIL LIMITED/RAINOIL GAS LIMITED shall notify the community of the movement on the waterways | L |
| | Pirate attacks and kidnappings | H | • Rainoil Limited/Rainoil Gas Limited shall make adequate security arrangements. | M |

| **Project Activity** | **Description of Impact** | **Rating before mitigation** | **Mitigation measures** | **Rating after mitigation** |
|---|---|---|---|---|
| | | | • Rainoil Limited/Rainoil Gas Limited shall ensure that members of staff are sensitized on the peculiarity of the project environment. | |
| | Land traffic accidents | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• the creation of awareness amongst local communities on the potential of increase in traffic on land and the need for extra precautions through public enlightenment<br>• Compliance with Rainoil Limited/Rainoil Gas Limited journey management policy for land transport<br>• Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued.<br>• the provision of First Aid facilities in all vehicles & at sites<br>• the use of PPE at sites<br>• daily pep talks<br>• carry out job hazard analyses | L |
| | | | | |
| | Impairment of air quality by emission of air pollutants including greenhouse gases | M | • Rainoil Limited/Rainoil Gas Limited shall use only pre-mobbed equipment.<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that there is controlled use of all equipment and that the engines are turned off when not in use. | L |
| **Site Preparation (vegetation clearing)** | Increase in Social vices | H | ▪ Rainoil Limited/Rainoil Gas Limited shall ensure:<br>▪ intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol and sexual promiscuity in the community and among workers | L |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation |
|---|---|---|---|---|
| | | | ▪ that contractor enforces the alcohol and drug policy for its staff<br>▪ regular medical check-ups are conducted for project work force<br>▪ condoms are provided for workers | |
| | Influx of migrant workers and camp-followers | M | Rainoil Limited/Rainoil Gas Limited shall:<br>• provide accommodation with necessary amenities at the base camp for its workers to reduce pressure on the pr-existing facilities<br>• ensure that there is site and camp base clinics/first aid and personnel<br>• ensure that local workforce be employed from the project communities in line with Nigerian Content Development (NCD) directives | L |
| | Loss of biodiversity | M | Rainoil Limited/Rainoil Gas Limited shall limit clearing and all earth digging activities to necessary areas<br>• RAINOIL LIMITED/RAINOIL GAS LIMITED shall carry out the re-vegetation of cleared area. | L |
| | Work site accidents | M | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• the creation of awareness amongst local communities on the potential of increase in traffic on land<br>• compliance with Rainoil Limited/Rainoil Gas Limited journey management policy for land transportation<br>• That all vehicles are pre-mobbed and pre-mobilization/compliance certificate issued.<br>• the provision of First Aid facilities in all vehicles at sites<br>• compensation for proven project-induced injuries, accidents | L |

| **Project Activity** | **Description of Impact** | **Rating before mitigation** | **Mitigation measures** | **Rating after mitigation** |
|---|---|---|---|---|
| | | | and fatalities<br>• enforcement of the use of PPE at sites<br>• daily pep talks are conducted<br>• shall carry out job hazard analyses | |
| | | | | |
| **Movement of construction equipment to Site** | Interference with land transportation | H | Rainoil Limited/Rainoil Gas Limited shall<br>• well planned road activities/usage<br>• proactively engage the community prior to any blockages of the roadways | L |
| | Pirate attacks and kidnappings | H | • Rainoil Limited/Rainoil Gas Limited shall make adequate security arrangements<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that members of staff are sensitized on the peculiarity of the project environment. | M |
| | | | | |
| **Site Construction Equipment / Facility Set-Up** | Increase in noise and vibration levels | M | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• regular maintenance of dredgers<br>• dredgers are turned off when not in use<br>• dredger engines are fitted with effective silencers | L |

**Table 6.2: Summary of Existing Impacts and Mitigation Measures during operation and Maintenace Phase**

| Project Activity | Description of Impact | Rating Before Mitigation | Mitigation Measures | Rating After Mitigation |
|---|---|---|---|---|
| OPERATION AND MAINTENANCE | Increase in concentrations of $NO_2$ and $SO_2$ in the air due to incomplete combustion from power generating plant, heavy machinery, and vehicular activities | H | Upgrade to high efficiency flare nozzle | L |
| | Acidification of soil in Proposed project area | H | Upgrade high efficiency flare nozzle | L |
| | Successional changes in the plant cover due to dumping of dredge spoils along the shoreline and slots | H | Re-use of dredge spoil for reclamation purposes | |
| | Increased levels of heavy metals in plant tissues | H | Immediate clean-up of crude oil spill (likely source of heavy metals) by physical processes<br>Remediation (bioremediation) of contaminated soil | M |
| | Decrease in wildlife as a result of increased hunting and habitat loss | H | Limit land take to proposed project<br>Increase surveillance to reduce poaching and lumbering activities<br>Create alternative source of income generation | L |
| | Increased access to forest resources as a result of construction activities leading to deforestation | H | Limit land take to proposed project<br>Increase surveillance to reduce poaching and lumbering activities<br>Create alternative source of income generation | L |
| | Nominal increase in income of members of the community as a result of employment generating activities from the 500MT LPG Blending Plant activities | P | Positive Impact | |

| Project Activity | Description of Impact | Rating Before Mitigation | Mitigation Measures | Rating After Mitigation |
|---|---|---|---|---|
| | Occupational shift to crop farming and hunting due to availability of fertile lands associated with the dumping of dredge spoils | P | Positive Impact | |
| | Decrease in access to potable water as a result of communal crises | H | Proactive engagement with communities<br>Implementation of PGMoU | L |
| | Increase in numbers and access to health facilities | P | Positive Impact | |
| | Decrease in child and maternal mortality | P | Positive Impact | |
| | Increase in non-communicable diseases | M | Step-up health education and sensitisation activities prior commencing construction activities and support condom donation initiatives.<br>Rainoil Limited/Rainoil Gas Limited shall organise awareness session on communicable diseases related to water and sexual behaviour.<br>Step-up HIV/AIDS awareness programmes. Augment the supply and issue of condoms to workers on the project and possibly extend to commercial sex workers in the vicinity if identified. | L |
| | Increase in levels of alcohol and cigarette consumption | M | Step-up health education and sensitisation activities prior commencing construction activities | L |
| | Third party agitation | H | Rainoil Limited/Rainoil Gas Limited shall:<br>ensure effective consultation with stakeholders<br>Ensure commitment and transparent adherence to PGMoU programmes and projects.<br>Identify and address legacy issues | M |

**Table 6.3: Impact Mitigation Measures for Proposed 500MT LPG Blending Plant Project at Ibusa (Decommissioning/Abandonment Phase)**

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation |
|---|---|---|---|---|
| **Dismantling of Equipment/facility and site clean-up** | Impairment of air quality by emission of air pollutants including greenhouse gases | M | • Rainoil Limited/Rainoil Gas Limited shall use only pre-mobbed equipment<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use. | L |
| | Increase in noise and vibration levels | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• regular maintenance of vessels and vehicles<br>• Vessels and vehicles are turned off when not in use<br>• combustion engines are fitted with effective silencers<br>• regular maintenance of machines and equipment<br>• machinery covers and panels are closed and well fitted at all times<br>• equipment with low noise level are used<br>• Rainoil Limited/Rainoil Gas Limited shall provide appropriate PPE | L |
| | Loss of employment/income | H | • Rainoil Limited/Rainoil Gas Limited shall support entrepreneurial skill development and opportunities for community members to cushion the effect of reduction in economic/income generating activities. | L |
| | | | | |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation |
|---|---|---|---|---|
| **Movement of personnel and equipment from site** | Interference with land transportation | M | • Rainoil Limited/Rainoil Gas Limited shall minimize movement during peak hours<br>• Rainoil Limited/Rainoil Gas Limited shall notify the community of any blockages of the roadways | L |
| | Pirate attacks and kidnappings | H | • Rainoil Limited/Rainoil Gas Limited shall make adequate security arrangements<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that members of staff are sensitized on the peculiarity of the project environment | M |
| | Land traffic accidents | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• the creation of awareness amongst local communities on the potential of increase in traffic on land and the need for extra precautions through public enlightenment<br>• compliance with Rainoil Limited/Rainoil Gas Limited journey management policy for land transportation<br>• Quarterly trainings for vehicle driver/operators<br>• Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued<br>• that all personnel shall have relevant road/operation certificate of proficiency<br>• the provision of First Aid facilities in all vehicles & at sites<br>• the use of PPE at sites<br>• daily pep talk<br>• carry out job hazard analyses | L |

# CHAPTER SEVEN

# ENVIRONMENTAL MANAGEMENT PLAN

## 7.1 General

Environmental management is concerned with a planned and integrated programme aimed at ensuring that adverse impacts of a proposed project are contained and brought to acceptable minimum levels, while the positive impacts are enhanced to optimize the benefits. Environmental management provides confidence on the part of project planners that a reliable scheme has been put in place to deal with any contingency that may arise during all phases of the project development, from from feasibility study to abandonment.

In keeping with Rainoil Limited/Rainoil Gas Limited policy on the environment, considerations of environmental implications of this project began from feasibility study, conceptual design and will continue throughout the project life cycle. This Environmental and Social Management Plan report is part of the environmental management programme, and is intended to provide an environmental input into the planning and execution of the project. Environmental management will be carried out in accordance with the provisions of ISO 14001 sections 4.3.2 to 4.3.4, NMDPRA and FMEnv.

## 7.2 Objectives of EMP

The EMP has the following specific objectives:

- The adoption of a systematic procedure to ensure that the Project activities are executed in compliance with all applicable legislations and Rainoil Limited/Rainoil Gas Limited HSSSE (and other) policies and guidelines;
- Demonstration that mitigation measures for all impacts and effects have been put in place and that the measures shall be adhered to throughout the project development life cycle;
- Demonstration that effective recovery measures for managing ‘lost control’ situations throughout the Project life cycle;
- Establishment of a structure that will ensure compliance by Rainoil Limited/Rainoil Gas Limited and its Contractors with the EMP.

In order to accomplish the above targets, the EMP has considered each environmental, social and health impact from the point of view of the Valued Ecosystem and Social Component(s) (VEC/VSC) to be monitored, as well as the parameters for their monitoring (**Table 7.1- 7.3**). It also specifies the responsible party/parties for each action.

In developing this EMP, Rainoil Limited/Rainoil Gas Limited recognizes that sound environmental management of the proposed project can only be guaranteed through the integration of the provisions of the plan as an integral part of business quality management. To this end Rainoil Limited/Rainoil Gas Limited shall put in place measures to enforce compliance by the project team on a daily basis throughout the duration of the project.

**Table 7.1: Environmental Management Plan (EMP) of 500MT Blending Plant Project (Pre-Operational Phase)**

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| **Land acquisition and survey** | Exposure of workers to wildlife attack | M | • Rainoil Limited/Rainoil Gas Limited shall provide and enforce usage of PPE by field workers.<br>• Rainoil Limited/Rainoil Gas Limited shall provide First aid/Anti venom and insect repellant on site.<br>• Rainoil Limited/Rainoil Gas Limited shall create awareness among site workers and nearby communities on the likelihood of exposure to wildlife | L | • Evidence of provision of PPE/first aid facility<br>• Awareness campaign records | Daily | Rainoil Limited/Rainoil Gas Limited/FMEnv/NMDPRA |
| | Legacy issues | H | ▪ Rainoil Limited/Rainoil Gas Limited shall identify and settle all outstanding legacy issues within the project area | M | • Records of legacy issues identified/resolved | Quarterly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Reduction of access to land and its resources | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>▪ thorough assessment of land requirements before additional land take;<br>▪ appropriate compensation is paid for any additional land take;<br>▪ provision of encouragement for the adoption of alternative means of | M | • Site inspection report<br>• Map of Project Site<br>• Post-construction dimensions<br>• Evidence of | Once before, during and after construction | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | livelihood e.g., a micro credit scheme | | disbursement of compensation<br>• Evidence of provision of alternative means of livelihood. | | |
| | Third party agitations | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>▪ management of public expectations by engaging the communities<br>▪ regular/periodic dialogue sessions with the communities<br>▪ adoption of appropriate community entry strategies;<br>▪ commitment to transparent adherence to GMoU programmes and projects<br>▪ improvement of company-media relations<br>▪ it obtains the Freedom to Operate (FTO) | M | • Records of public engagement sessions.<br>• Records of minutes of meetings.<br>• Records of Third Party Grievances.<br>• Records of GMoU implementation status. | Quarterly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | | | | | | | |
| | Impairment of air quality by emissions of air | H | • Rainoil Limited/Rainoil Gas Limited shall use only pre-mobbed boats<br>• Rainoil Limited/Rainoil Gas Limited | L | • Monitoring records of the criteria air | Monthly | Rainoil Limited/Rainoil Gas Limited |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | pollutants including greenhouse gases | | shall ensure that there is controlled use of all vessels and that their engines are turned off when not in use. | | pollutants<br>• Vehicle/boat maintenance records<br>• Vehicle/boat pre-mob records | | /FMEnv/NM DPRA |
| | Increase in incidence of STI's including HIV | H | • Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• regular medical check-ups are conducted for the project work force<br>• condoms are provided for workers<br>• restriction of workers into the camp | M | • Enlightenment campaign records<br>• Evidence of issuance of condoms<br>• Records of regular medical records | Monthly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NM DPRA |
| | Increase in noise and vibration levels | M | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• regular maintenance of heavy machinery in use<br>• Heavy machinery are turned off when not in use<br>• Heavy machinery and vehicles engines are fitted with effective silencers | L | • Noise monitoring records<br>• Maintenance records<br>• Vehicle/boat pre-mob records | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NM DPRA |
| **Movement of personnel and** | Interference with land | M | • Rainoil Limited/Rainoil Gas Limited shall minimize movement at the peak | L | | | |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| **equipment to site** | transportation | | hours of land transportation<br>• Rainoil Limited/Rainoil Gas Limited shall notify the community on any blockages of the roadways | | | | |
| | Pirate attacks and kidnappings | H | • Rainoil Limited/Rainoil Gas Limited shall make adequate security arrangements.<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that members of staff are sensitized on the peculiarity of the project environment. | M | • State/ company Security/Incident Reports<br>• Evidence of approved security plans<br>• Evidence of staff sensitization sessions | Daily | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Road traffic accidents | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• the creation of awareness amongst local communities on the potential of increase in traffic on land and the need for extra precautions through public enlightenment<br>• compliance with Rainoil Limited/Rainoil Gas Limited journey management policy for land transportation | L | • Records of awareness sessions<br>• Journey management records; IVMS records<br>• Rainoil Limited/Rainoil Gas Limited drivers permit/ | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | • Quarterly trainings for vehicle driver/operators<br>• Vehicles are pre-mobbed and pre-mobilization/compliance certificate issued<br>• that all personnel shall have relevant road certificate of proficiency<br>• the provision of First Aid facilities in all vehicles & at sites<br>• the use of PPE at sites<br>• daily pep talk<br>• carry out job hazard analysis | | DEP certificates<br>• First aid box and contents<br>• Maritime accident records<br>• Minutes of pep talk meetings<br>• Site inspection report<br>• Incident reports (injuries / fatalities). | | |
| | | | | | | | |
| **Site Preparation (vegetation clearing)** | Exposure of workers to wildlife attack | M | Rainoil Limited/Rainoil Gas Limited shall provide and enforce usage of PPE by field workers.<br>Rainoil Limited/Rainoil Gas Limited shall provide First aid/Anti venom and insect repellant on site.<br>Rainoil Limited/Rainoil Gas Limited shall create awareness among site workers and nearby communities on the likelihood of exposure to wildlife | L | • Evidence of provision of PPE/first aid facility<br>• Awareness campaign records | Daily | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Impairment of air quality by | M | Rainoil Limited/Rainoil Gas Limited shall use only pre-mobbed equipment. | L | • Monitoring records of the | Monthly | Rainoil Limited/Raino |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | emissions of air pollutants including GHG | | Rainoil Limited/Rainoil Gas Limited shall ensure that there is controlled use of all equipment and that the engines are turned off when not in use. | | criteria air pollutants<br>• Vehicle/equipment maintenance records<br>• Vehicles pre-mob records | | il Gas Limited /FMEnv/NM DPRA |
| | Increase in Social vices | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>▪ intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol and sexual promiscuity in the community and among workers<br>▪ that contractors enforce the alcohol and drug policy for their staff<br>▪ regular medical check-ups are conducted for project work force<br>condoms are provided for workers | L | • Enlightenment campaign records.<br>• Records of alcohol/drug policy<br>• Evidence of issuance of condoms.<br>• Records of regular medical records. | Monthly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NM DPRA |
| | Influx of migrant workers and camp-followers pressure on existing infrastructure | M | Rainoil Limited/Rainoil Gas Limited shall:<br>• provide accommodation with necessary amenities at the base camp for its workers to reduce pressure on the pre-existing facilities | L | • Evidence of workforce<br>• accommodation<br>• Employment records | Quarterly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NM DPRA |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | • ensure that there is site and camp base clinics/first aid and personnel<br>• ensure that local workforce is employed from the project communities in line with Nigerian Content Development (NCD) directives | | | | |
| | Loss of biodiversity | M | Rainoil Limited/Rainoil Gas Limited shall limit clearing and all earth digging activities to necessary areas<br>• Rainoil Limited/Rainoil Gas Limited shall carry out the re-vegetation of cleared area. | L | • Record of vegetation clearing<br>• Record of re-vegetation | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Work site accidents | M | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• the creation of awareness amongst local communities on the potential of increase in traffic on land and water<br>• compliance with Rainoil Limited/Rainoil Gas Limited journey management policy for land and water transport<br>• Quarterly trainings for vehicle driver/operators<br>• that all vehicles/equipment are pre- | L | • Records of issuance of PPE<br>• Records of toolbox meeting<br>• Evidence of approved JHA<br>• HSSSE incident records<br>• Driver | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | mobbed and pre-mobilization/compliance certificate issued<br>• that all personnel for road related operations shall have relevant certificate of proficiency<br>• the provision of First Aid facilities in all water borne crafts at sites<br>• compensation for proven project-induced injuries, accidents and fatalities<br>• enforcement of the use of PPE at sites<br>• that daily pep talks are conducted<br>• shall carry out job hazard analysis | | certifications<br>• Safety training records Pre-mob records<br>• Relevant certificates to job description<br>• Evidence of first aid boxes on all vehicles at sites | | |
| | | | | | | | |
| **Movement of construction equipment to Site** | Interference with land transportation | H | Rainoil Limited/Rainoil Gas Limited shall:<br>• minimize river crossing time<br>• proactively engage the community prior to any blockages of the roadways<br>• minimize movement during peak community movement time | L | • Record of high land/road usage time<br>• Evidence of community engagement<br>• Record of travel time | Daily | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Pirate attacks and kidnappings | H | • Rainoil Limited/Rainoil Gas Limited shall make adequate security arrangements. | M | • State/ company Security/Incident Reports | Daily | Rainoil Limited/Rainoil Gas Limited |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | • Rainoil Limited/Rainoil Gas Limited shall ensure that members of staff are sensitized on the peculiarity of the project environment | | • Evidence of approved security plans<br>• Evidence of staff sensitization sessions | | /FMEnv/NMDPRA |
| **Site Construction Equipment / Facility Set-Up** | Noise and vibration nuisance | M | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• regular maintenance of cranes and other heavy equipment used for construction<br>• cranes and other heavy equipment used for the rig set-up are turned off when not in use<br>• that the engine cranes and other heavy equipment used for construction are fitted with effective silencers | L | • Equipment maintenance records<br>• Equipment pre-mob records | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |

**Table 7.2: Environmental Management Plan (EMP) of the Proposed 500MT LPG Blending Plant Project at Ibusa (Operational Phases)**

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| **OPERATION AND MAINTENANCE** | Increase in concentrations of $NO_2$ and $SO_2$ in the air due to incomplete combustion from power generating plant, heavy machinery, and vehicular activities | H | Upgrade to high efficiency flare nozzle | L | • Monitoring records of the criteria air pollutants<br>• boat maintenance records<br>• Vehicle/boat pre-mob records | Monthly | Rainoil Limited/Rain oil Gas Limited /FMEnv/NMDPRA |
| | Acidification of soil in Proposed project area | H | Upgrade high efficiency flare nozzle | L | • Monitoring records of the air pollutants<br>• Boat maintenance records<br>• Boat pre-mob records | Monthly | Rainoil Limited/Rain oil Gas Limited /FMEnv/NMDPRA |
| | Successional changes in the plant cover due to dumping of dredge spoils along the shoreline and slots | H | Re-use of dredge spoil for reclamation purposes | | • Noise monitoring records<br>• Maintenance records<br>• Rig pre-mob records | Weekly | Rainoil Limited/Rain oil Gas Limited /FMEnv/NMDPRA |
| | Increased levels of heavy metals in plant | H | Immediate clean-up of crude oil spill (likely source of heavy | M | • Approved Mud density records | Daily | Rainoil Limited/Rain |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | tissues | | metals) by physical processes<br>Remediation (bioremediation) of contaminated soil | | • Sub-surface pressure monitoring records | | oil Gas Limited /FMEnv/NMDPRA |
| | Decrease in wildlife as a result of increased hunting and habitat loss | H | Limit land take<br>Increase surveillance to reduce poaching and lumbering activities<br>Create alternative source of income generation | L | • Waste management records | Daily | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Increased access to forest resources as a result of construction activities | H | Limit land take to proposed site<br>Increase surveillance to reduce poaching and lumbering activities<br>Create alternative source of income generation | L | • | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Nominal increase in income of members of the community as a result of employment generating activities from the 500MT LPG Blening Plant activities | P | Positive Impact | | • Job generation<br>• Evidence of community engagement | Monthly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Decrease in access to | H | Proactive engagement with | L | • Evidence of community | | Rainoil |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | potable water as a result of communal crises | | communities<br>Implementation of PGMoU | | involvement | | Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Increase in numbers and access to health facilities | P | Positive Impact | | • Records of Health facilities | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Decrease in child and maternal mortality | P | Positive Impact | | • Enlightenment campaign records.<br>• Records of regular medical records. | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Increase in non-communicable diseases | M | Step-up health education and sensitisation activities prior commencing construction activities and support condom donation initiatives.<br>Rainoil Limited/Rainoil Gas Limited shall organise awareness session on communicable | L | • Enlightenment campaign records.<br>• Records of regular medical records.<br>• Evidence of issuance of condoms. | Weekly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | diseases related to water and sexual behaviour.<br>Step-up HIV/AIDS awareness programmes. Augment the supply and issue of condoms to workers on the project and possibly extend to commercial sex workers in the vicinity if identified. | | | | |
| | Increase in levels of alcohol and cigarette consumption | M | Step-up health education and sensitisation activities prior commencing construction activities | L | • Records of alcohol/drug policy | Monthly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Third party agitation | H | Rainoil Limited/Rainoil Gas Limited shall:<br>ensure effective consultation with stakeholders<br>Ensure commitment and transparent adherence to PGMoU programmes and projects.<br>Identify and address legacy issues | M | • Records of Third Party Grievances<br>• Records of work stoppages at locations.<br>• Records of G-MoU programmes implementation<br>Minutes of meetings | | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |

**Table 7.3: Environmental Management Plan (EMP) of the Proposed 500MT LPG Blending Plant Project at Ibusa (Decommissioning /Abandonment Phase)**

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | Impairment of air quality by emissions of air pollutants including greenhouse gases | M | • Rainoil Limited/Rainoil Gas Limited shall use only pre-mobbed equipment<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use. | L | • Monitoring records of the criteria air pollutants<br>• boat maintenance records<br>• Vehicle/boat pre-mob records | Monthly | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Increase in noise and vibration levels | M | • Rainoil Limited/Rainoil Gas Limited shall use only pre-mobbed equipment<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use. | L | • Pre-mob records | | |
| | Loss of income/employment | H | • Rainoil Limited/Rainoil Gas Limited shall support entrepreneurial skill | L | • Disengagement records | | |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | development and opportunities for community members to cushion the effect of reduction in economic/income generating activities. | | | | |
| **Movement of personnel and equipment out of site** | Interference with land transportation | M | • Rainoil Limited/Rainoil Gas Limited shall minimize movement at the peak hours of land transportation<br>• Rainoil Limited/Rainoil Gas Limited shall notify the community of any possible blockages on roadways | L | • Journey management record<br>• Evidence of communication to community | | |
| | Pirate attacks and kidnappings | H | • Rainoil Limited/Rainoil Gas Limited shall make adequate security arrangements.<br>• Rainoil Limited/Rainoil Gas Limited shall ensure that members of staff are sensitized on the peculiarity of the project environment. | M | • State/ company Security/Incident Reports<br>• Evidence of approved security plans<br>• Evidence of staff sensitization sessions | Daily | Rainoil Limited/Rainoil Gas Limited /FMEnv/NMDPRA |
| | Land traffic accidents | H | Rainoil Limited/Rainoil Gas Limited shall ensure:<br>• the creation of awareness | L | • Records of awareness sessions<br>• Journey management | Weekly | Rainoil Limited/Rainoil Gas |

| Project Activity | Description of Impact | Rating before mitigation | Mitigation measures | Rating after mitigation | Parameters to be Monitored | Monitoring Frequency | Responsible/ Action Party |
|---|---|---|---|---|---|---|---|
| | | | amongst local communities on the potential of increase in traffic on land and the need for extra precautions through public enlightenment<br>• compliance with Rainoil Limited/Rainoil Gas Limited journey management policy for land transport<br>• Quarterly trainings for vehicle driver/operators<br>• water borne crafts are pre-mobbed and pre-mobilization/compliance certificate issued<br>• that all personnel for water related operations shall have certificate of swimming proficiency<br>• the provision of First Aid facilities in all water borne crafts & at sites<br>• the use of PPE at sites<br>• daily pep talk<br>• carry out job hazard analysis | | records; IVMS records<br>• Rainoil Limited/Rainoil Gas Limited drivers permit/ DEP certificates<br>• First aid box and contents<br>• Land accident records<br>• Minutes of pep talk meetings<br>• Site inspection report<br>• Incident reports (injuries / fatalities).<br>• Driving/operation certificate | | Limited /FMEnv/NMDPRA |

# CHAPTER EIGHT

## 8.0 CONCLUSIONS

Rainoil Limited/Rainoil Gas Limited has carried out the Environmental and Social Management Plan (ESMP) of the proposed 500MT LPG Blending Plant Project at Ibusa, Ughelli South Local Government Area, Delta State. This was carried in order to predict the impact of the proposed project activities on the various biophysical and socio-economic components of the project environment and host communities and also to proffer adequate mitigation and enhancement measures for adverse and beneficial impacts respectively.

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

Data acquisition from terrestrial, aquatic and socio-economic environment as well as the assessment of the sensitivities of the various biophysical and socio-economic parameters involved a multi-disciplinary approach. Consultations with the host communities, local government authority and officers as well as regulatory authorities are ongoing and shall continue throughout the project life cycle.

The impacts assessment of the proposed development project shows that it will impact positively on the national economy as well as the revenue base of the project proponent and contribute to socio-economic development within the host communities and result in economic empowerment for the indigenes and residents as well as other professionals. These would be by way of increased petroleum products distribution, skilled and semi-skilled employment opportunities, award of contracts for supplies and services among others.

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

Considering the workable proffered mitigation measures for adverse impact, the benefits of the proposed project outweighs the negative impacts. In view of the foregoing, Rainoil Limited/Rainoil Gas Limited requests that the project be approved for implementation.

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# APPENDICES

## APPENDIX A: FIELD DATA GATHERING METHODOLOGIES

***Climate and Meteorology Studies***

Prevailing climatic conditions was sourced from existing literature to compliment field data which included the following parameters: Rainfall, Ambient temperature, Wind direction and Speed, Solar radiation, Atmospheric Pressure, Relative Humidity, and Cloud Cover. Climatic field data were obtained using Oregon Weather equipment (see Plate A1).

***Air Quality Studies:*** Twelve (12) air quality sampling points were established within the proposed project area. The GT-331 VI.04 A Met One Instrument, Inc. Aerosol Mass Monitor Model GT-331 was used in determination of suspended particulate matter (SPM). Levels of VOC were measured using a MultiRAE PLUS (PGM- 50), a programmable Multi Gas monitor used to monitor organic vapours. $H_2S$, $CO_2$, CO, $SO_2$, and $NO_x$ were measured using an Industrial Scientific Corporation ITX Multi-Gas monitor. Measurements were done by holding the sensor to a height of about two meters in the direction of the prevailing wind and readings recorded at stability (See Plate A2).

**Plate A2: Air quality Monitoring**

***Noise (sound) Level***

Noise levels were measured at eleven (11) sampling stations using a Cole-Parmer Extech Model 407736 Sound Level Meter. The instrument is hand-held and digital. The equipment measures noise via a microphone probe that generates signals approximately proportional to located sound waves. Measurements were done by directing the probe towards the direction of the prevailing wind and readings recorded at stability. The sound level measured was viewed from the reading on the meter LCD.

***Geology and Hydrogeology***

Two (2) boreholes were drilled at the project area and one (1) drilled outside the proposed project area for control using a 5 – inch hand auger to drill each of the boreholes to 12.0 meters. Samples recovered from the auger were used for lithologic log description, while the borings were installed with piezometers for water level measurements and determination of groundwater flow direction.

The static water level (SWL) in the boreholes was measured with a water level indicator model ELWA-PL 15. Local groundwater flow direction was determined in the area using data generated from the first three boreholes drilled. To achieve this, the boreholes were located in a triangular manner and their positions were noted. The depth to water in each borehole was measured with the water level indicator, while the elevation of the borehole above mean sea level was measured with a Garmin Geographical positioning system (GPS) 12. The depth to water in each borehole was then subtracted from the elevation of the borehole to obtain the total head of water at that point. A triangle was drawn on the map with the boreholes (and their respective total head values) at the apices. Equipotential lines were drawn, and perpendicular lines to the equipotential lines gave the groundwater flow direction in the area.

Groundwater samples were collected from the boreholes drilled within the project area and at the control points. The water samples were collected in clean new plastic bottles for physico-chemical analysis. Samples for microbiological analysis were collected in Mc Cartney bottles while samples for heavy metals were collected in glass bottles acidified with concentrated sulphuric acid.  After each collection, the container lid was replaced immediately to avoid oxygen contamination. The samples were stored in an ice-packed cooler and transported to the Tudaka Analytical Nigeri Limited for analysis.

**Plate A2: Borehole monitoring well (ungoing drilling)**

***Soil Studies***

Field protocols were carried out to meet the needs of the baseline study and for information that were adequate and suitable for achieving valuable results.

The major considerations for soil sample distribution and sampling pattern were:

- Adequate coverage of representative and / or probable soil morphological types within the study area;
- Capturing the possible effects of existing land use patterns on soil environment and;

- Establishing the potential impact(s) of the proposed project on the soil environment, including the land use patterns in the area.

From the field sampling plan, which was based on the project location map and reconnaissance visit to the area, a total of ten (10) soil sample stations (both top and bottom) were established, spreading within and around the project location.

At each of the sample stations, at least, three random spots were augered at two depth levels (Top Sample (T), 0 – 15cm; Bottom Sample (B), 15- 30 cm), with the aid of 9cm diameter dutch auger at about the centre of the sample station (Anon., 1986). At each of the sample stations (SS) and soil depth levels (T or B), the soil samples were bulked together to give a composite sample. The soil samples from different sample stations and soil depth levels were, on each occasion, collected in polythene bags and labeled accordingly (**see Plate A3**). For example, soil sample from first sample station (i.e. SS1) and first depth level (0-15cm) (i.e.; T) was coded as SS1T. Samples for physico-chemical analysis shall be collected into coded plastic bags, while glass containers with screw cap, lined with Teflon and sterile plastic bottles were used to collect samples for microbiology analysis respectively.

**Plate A3: Soil sampling during the Field Work**

***Vegetation***

Assessment of the vegetation around the proposed project was carried out in transects, established around the site. The transects were also orientated such as to increase the probability of including most plants occurring in the area. To facilitate vegetation monitoring in future and assess magnitude of change due to the project, efforts were made to locate transects in sites where the impacts are likely to be felt and close to the soil sampling stations.

All plant species found along each transect were as much as possible identified, counted and listed in the field. Taxonomically difficult forms (which could not be immediately identified with certainty) were collected, properly labelled, pressed and subsequently transported to the Herbarium of Dept of University of Port Harcourt, Port Harcourt for further keying and identification. Throughout the period plant identification followed the well-illustrated keys of Hutchinson and Dalziel (1968), Stanfield (1970), Lowe and Stanfield (1974) and Akobundu and Agyakwa (1998). From the counts taken for each species the percentage frequencies of occurrence were estimated right on the field. Thereafter, the plants were scrupulously screened for any pathological conditions arising from insect pests, fungal/bacterial infections and unfavourable environmental variables (Hill and Waller, 1982).

***Wildlife***

Investigations into the wildlife species resident around the proposed project area were conducted using a combination of conventional methods (Moshby 1964, Dasmann 1963, Sutherland 2000 and Davies 2002). The combinations of techniques are considered quite appropriate, since the major objective was to provide a comprehensive checklist of wild animals' characteristic by the area and highlight their conservation status. The methods fall into two major categories. (a) Indirect method namely: (i) Interview technique which involves interacting with indigenous hunters and peasant farmers who are conversant with the terrain, wildlife habitat and diversity. (ii) Use of evidence of animal presence or occupation. (b) Direct Method which involves direct search of animals in the area under question to physically spot them, either by probing their habitat, hide outs, and/or using binoculars to locate and identify them.

Ten (10) indigenous hunters of proposed area within the age brackets of 25 – 60, who were willing to be interviewed, were engaged as escorts during the survey. In the process, the interviewed hunters were urged to describe the kinds and behaviour of animals resident in their bushes, indicate bushes of high faunal density, the most abundant and rarest species, and the date of last kill or sighting, to give insight to their conservation status. Interviewing of locals as adopted in this study, has been acknowledged by several wildlife ecologists as veritable source of information for the wildlife of any place. The hunters were also urged to present for examinations, remains of animals caught around proposed Project area such as skeleton (skull), hairs, feathers, scales, hoofs, harns, etc as well as provide date and year of capture, where possible. Colour plants of West African forest animals were also made available to the hunters for confirmation.

The interview session was followed by direct field search for wildlife around the vegetation transects and neighbourhood. The search was conducted radially (in the northern, southern, eastern and western directions) to increase the chances of encountering most wildlife and wildlife habitats or their evidence of presence. In recognition of the fact that animals' peak of activities vary, the search for wildlife was carried out in the mornings (6.00am – 9.00am), midday (11.00 – 2.00pm) and sunset (3.00 – 6.00 pm) daily, in the process probing humid habitats such as vegetation undergrowths, burrows, rock crevices, with a prop and collecting / recording animal remains (droppings, carcass foot prints, sloughed skin, etc) found. Throughout the period, a walking rate of about 1km/hr was maintained, and stopovers were made at intervals of 3-5 minutes to listen to animal calls or vocalization. Tree crowns and branches were also screened using high power binoculars (Fujiyama model) to detect arboreal forms such as birds, squirrels, pangolins, primates, snakes, etc.

All captured, dislodged or sighted animals were identified to possible taxonomic levels, using the field guides or keys of Happold (1987) and Kingdom (1997) for mammals; Elgood et al (1994), Elgood (1960) for birds; Branch (1988) for reptiles; Webbs et al (1981) and Schiotz (1969) for Amphibians.

## APPENDIX B: TERMS OF REFERENCE

# FEDERAL MINISTRY OF ENVIRONMENT

Environment House
Independence Way South, Central Business District, Abuja - FCT.
Email: info@ead.gov.ng, www.ead.gov.ng, www.eia@ead.gov.ng

## ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMEnv/EA/EIA/9793/Vol.1/55
26th June, 2026

The Managing Director,
Rainoil Limited,
No. 35, Kofo Abayomi Street,
Victoria Island,
Lagos State.

**RE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN FOR THE PROPOSED 500MT MINI LIQUIFIED PETROLEUM GAS (LPG) BLENDING DEPOT AT UMUOBIEGWUTU FAMILY LAND, IDUMUOBI-OGALAWA ETITI, OGBEOWELE QUARTERS, IBUSA, OSHIMILI NORTH LGA, DELTA STATE.**

Please refer to your letter to the Ministry dated 23rd June, 2026 on the above subject.

2. I am directed to acknowledge the receipt of your letter, project Terms of Reference (ToR), and evidence of payment of Fifty Thousand Naira (N50,000) only being the EIA registration fee for the proposed project.

3. Following the evaluation of your submission, I am further directed to inform you that the ToR has been adjudged adequate for the study. The next stage of the EIA process is the site verification exercise, which will be carried out by officials of the Ministry in collaboration with Ogun State Ministry of Environment. Kindly ensure adequate samples are collected with the following minimum for the baseline study of the project area as shown in the table below-

| S/N | ENVIRONMENTAL COMPONENTS | ANALYSIS TYPE | PROPOSED NUMBER OF SAMPLES/DISTRIBUTION | RECOMMENDED NUMBER OF SAMPLES/DISTRIBUTION | PARAMETERS TO BE MONITORED |
|---|---|---|---|---|---|
| i. | Climate/Meteorology | - | - | - | Rainfall pattern, Relative humidity and Temperature, Wind speed, direction and visibility and their local effects |
| ii. | Air Quality | Ambient | 10 + 2 control samples | 40 + 5 control samples | $NO_2$, NO, $SO_2$, $NH_3$, CO, VOCs, $H_2S$, $CH_4$, temperature, particulates, relative humidity |
| iii. | Noise level | Noise level | 10 + 2 control samples | 40 + 5 control samples | Noise level; dB(A) |
| iv. | Soil Samples (Top and Subsoil) | Physico-chemical/ microbial | 10 + 2 control samples | 40 + 5 control samples | Temperature, Colour, pH, Salinity, hardness, Texture, Porosity, Bulk Density, heavy metals: Zn, Pb, Fe, Hg, Ba, Phosphate, BTEX, TPH, Total heterotrophic bacteria and fungi, Total hydrocarbon utilizing bacterial and fungi Total coliform. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | grain size distribution etc. |
| v. | Ground Water | Physcio-chemical microbial | 2 | 10 + 2 control samples | Temperature, Colour, pH, Turbidity, Salinity, hardness, heavy metals-Zn, Pb, Fe, Hg, Ba etc. DO, BOD, COD, THC, Electrical conductivity, Phosphate, $SO_4$, $NO_3$, TSS, TDS, BTEX, TPH, grain size distribution etc. |
| vii. | Ecology | Vegetation | | General transects in vegetation around the project location/the impacted communities | Flora and fauna habitat status, floral composition, density and distribution, vegetation suction, plant pathology. |
| | | Wildlife | | Within and around the project area | |
| viii. | Socio-Economic/Health Characteristics | Project area/adjacent community (ies) | - | | Demography, social structure and organization, livelihood, social infrastructure, cultural properties, natural resources and land use, perception of the project, educational status, social vices and health impacts assessment indicators. |

4. In addition to the above, please note that you and your environmental Consultant shall be responsible for the following:

i. The accuracy, integrity, and completeness of the ESIA study,
ii. The accuracy of impact predictions and mitigation measures,
iii. Compliance with all applicable guidelines and standards,
iv. Any negligence or omission during the ESIA study shall be remediated by your organization.

5. Consequently, you are to pay the sum of Nine Hundred and Two Thousand, Five Hundred Naira (N902,500.00) only, for the exercise. You are also requested to kindly provide necessary logistics and Technical Personnel on site to ensure a hitch free exercise.
6. You may wish to contact the undersigned on GSM (07032747723) or Engr. (Mrs.) Charity B. Malgwi (08039730654) to confirm the receipt of this letter and for any clarification, please.
7. Thank you for your co-operation.

Mrs. Rofikat A. Odetoro
f. Director, Environmental Assessment Department
For: Honourable Minister

# FEDERAL MINISTRY OF ENVIRONMENT

Environment House
Independence Way South, Central Business District, Abuja - FCT.
Email: info@ead.gov.ng, www.ead.gov.ng, www.eia@ead.gov.ng

## ENVIRONMENTAL ASSESSMENT DEPARTMENT

FMEnv/EA/EIA/9793/Vol.1/57
25th June, 2026

**The Managing Director,**
Rainoil Limited,
No. 35, Kofo Abayomi Street,
Victoria Island,
Lagos State.

**RE: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN FOR THE PROPOSED 500MT MINI LIQUIFIED PETROLEUM GAS (LPG) BLENDING DEPOT AT UMUOBIEGWUTU FAMILY LAND, IDUMUOBI-OGALAWA ETITI, OGBEOWELE QUARTERS, IBUSA, OSHIMILI NORTH LGA, DELTA STATE.**

Please refer to your letter to the Ministry dated 23rd June, 2026 on the above subject.

2. I am directed to inform you that the Ministry's officials shall participate in the Baseline Data-Gathering and Laboratory Analyses exercises for the proposed project.

3. Consequently, you are to pay the sum Five Hundred Thousand Naira (₦500,000.00) only being the cost of the two (2) exercises. You are also requested to kindly provide the necessary logistics and technical personnel on-site to ensure a hitch-free exercises.

4. You may wish to contact the undersigned on GSM (07032747723) to confirm the receipt of this letter and for any clarification. please.

5. Thank you for your co-operation.

f- Mrs. Rofikat A. Odetoro
Director, Environmental Assessment Department
For: Honourable Minister

# APPENDIX C: LABORATORY ANALYTICAL METHODS AND PROCEDURE

## Water samples

Dissolved Oxygen, Conductivity, Salinity, pH, Total Dissolved Solids and Temperature of Water samples. These parameters were measured in-situ using the Multi-Parameter Water Quality Monitor (model 6000 UPG). The samples were collected in 50ml glass beakers and the equipment used to take the measurements directly.

## Conductivity, Salinity, pH, and Temperature of Sediment Samples

20.0g of fresh sediment samples was weighed into a 50ml beaker and 20ml of distilled water added to the beaker. The mixture was thoroughly stirred and allowed to stand for 30 minutes and the Multi-Parameter Water Quality Monitor was then used to measure the above parameters directly.

### *Total Suspended Solids (TSS)*

TSS was determined using the APHA 209D – Total Non-filtrate Residual Dried at 103-105$^{o}$C. The oven dried (at 105$^{o}$C for 1 hour) filter paper was used instead of glass fibre filter. The dried filter paper was weighed and then used to filter 100ml of the sample. The filter paper and the residue were then dried in the oven at 105$^{o}$C for 1 hour and allowed to cool. The paper and residue was then weighed and recorded. The drying cycle was repeated until a constant weight was attained i.e. until weight loss between successive weighing was less than 0.5mg. TSS was calculated as follows:

$$\text{TSS (mg/l)} = \frac{(A - B) \times 1000}{\text{Samples Volume (ml)}}$$

Where: A = Weight of filter paper

B = Constant weight of filter paper and filtrate

### *Particle Size Distribution*

PSD was determined using the hydrometer method followed by sieving recommended for sediment samples containing more than 35% fine particles i.e. clays and slits. The test method is based on the BS 1377 (part 2; 1990), which is in accordance with the Dutch RAW and the American ASTM D422.

***Total Microbial Count (water and Sediment samples)***

Indirect cell count on sediment and water samples was carried out to determine the total viable microbial populations. The test methods used are the ASTM D5465 – 93: Determining Microbial Colony Counts from Water Analysed by Plating Methods, and APHA 907: Standard Plate Count. Total microbial colonies were calculated as follows:

Plate Count (cfu/ml) = (No. of Colonies on Plate) x (Dilution factor).

***Phosphate – Phosphorus in Sediment***

Phosphate – Phosphorus in sediment samples was determined using UV/Visible spectrophotometer. The Stannous Chloride Reduction Method, based on the method described in the Chemical Analyses of Ecology Matter ($2^{nd}$ed), was applied. Phosphate – phosphorus content of sediment samples was calculated as follows.

$$\text{Phosphate – phosphorus (mg/kg)} = \frac{\text{C (mg/l) x Solution Volume (1) x 1000}}{\text{Aliquot x Sample weight (g)}}$$

Where C = mg phosphate obtained from calibration graph using the UV/Visible spectrometer and Vision software version 3

$$\text{Aliquot} = \frac{\text{Volume (ml) of extract used for analyses}}{\text{Volume (ml) of extractant used for the extraction}}$$

1000 = Conversion factor to kg

***Phosphate – Phosphorus (P) in Water***

The Phosphate-phosphorus content of water samples was determined by spectrophotometery using the UV-4 Unicam Spectrometer. Phosphate (mg/l) content was calculated as follows.

$$P\ (mg/l) = \frac{mg\ P\ (\text{in approximately } 104ml \text{ final volume}) \times 1000}{\text{Sample Volume (ml)}}$$

***Sulphate – Sulphur (S) in Sediment***

The test method used to determine sulphates-sulphur in sediment samples is the Turbidimeteric method, which is based on the method described in the Chemical Analysis of Ecological matter ($2^{nd}$ed.). The sulphates=sulphur (S) content was calculated as follows.

$$S\ (mg/kg) = \frac{C\ (mg) \times \text{Solution Volume (ml)} \times 1000}{\text{Aliquot (ml)} \times \text{Sample weight (g)}}$$

Where C = mg of S obtained from calibration graph

1000 = Conversion factor to kg

$$\text{Aliquot} = \frac{\text{Volume of extract used for analysis}}{\text{Volume of extractant solution used.}}$$

***Sulphate-Sulphur (S) in Water Samples***

The APHA 426C method (Turbidimeteric Method) described in the Standard Method for Examination of Water and Wastewater was used to determine the sulphates-sulphur content of water samples. S was calculated as follows:

$$S\ (mg/l) = \frac{Mg/l\ S \times 1000ml}{\text{Sample Volume (ml)}}$$

***Nitrate-Nitrogen (N) in Sediment Samples***

The Brucine Colorimetric method described in GEMS/Water Operation Guide, 1987 was used to determine the nitrate-nitrogen content of sediment samples. N was calculated as follows.

$$N\ (mg/kg) = \frac{mg\ (N)\ from\ calibration\ graph \times Volume\ of\ extractant \times 100}{Volume\ of\ extract\ (ml) \times Sample\ weight\ (g)}$$

Where the 1000 is the conversion factor to kg.

***Nitrate-Nitrogen (N) in Water Samples***

The test method used to determine the nitrate-nitrogen content water samples is the Brucine Colorimetric method described in the GEMS/Water Operational Guide, 1987. Nitrate-nitrogen content of water samples was calculated as follows.

N (mg/l) = (mg/l N from calibration graph) – (mg N from reagent blank)

***Oil and grease in Sediment Samples***

Oil and grease (OG) content of sediment samples was determined using Infra-Red (IR) Spectrophotometery following the ASTM D3921 method. The only deviation from the ASTM method was that 50mm cells were used for concentrations, which ranged from 0.5mg/l to 30mg/l.

The method used for extraction is the Dutch Standard Method VPRC 88 – 19 and the OG contents were calculated as follows.

$$OG\ (mg/g) = \frac{Instrument\ reading\ (mg/l) \times Volume\ of\ extract\ (l)}{Weight\ of\ Sample\ (g)}$$

***Total Petroleum Hydrocarbon (TPH) in Sediment/soil Samples***

Infrared Spectrophotometery, as described in ASTM D3921, was used to determine the TPH in sediment samples. The only deviation from the ASTM method was that 50mm cells were used for concentrations, which ranged between 0.5mg/l and 30mg/l. The method of extraction was the Dutch Standard Method VPRC 88 – 19 and TPH contents were calculated as follows.

$$\text{Actual TPH (mg/l)} = \frac{\text{Instrument reading (mg/l) x Volume of extract (l)}}{\text{Weight of Sample (g)}}$$

***Exchangeable Cations in Sediment/soil***

Exchangeable cations in sediments samples were determined using ATI Unicam Atomic Absorption Spectrophotometer (AAS), Model 939. The samples were prepared according to the procedure described in the ASTM D5198. Actual determination of exchangeable Cation contents was carried out in accordance with the procedures described below:

Na, Mg and K:APHA3111B ($18^{th}$ edition) / ASTM D3561

Al: APHA3111D ($18^{th}$ edition)

Ca: FPLL in-house method (FPLL Quality Systems Manual, 1999)

Cation contents were calculated as follows:

$$\text{Cation concentration (mg/kg)} = \frac{(A - B)\,C}{D}$$

Where: A = Concentration of metal in sample (mg/l) as determined by AAS

B = Concentration of the metal found in blank (mg/l)

C = Volume of extract (ml)

D = Weight of dry sample (g)

***Exchangeable Cations in Water***

Exchangeable cations in water samples were determined using ATI Unicam Atomic Absorption Spectrophotometer (AAS), Model 939. ASS measurements were carried out in accordance with the procedures described below.

Na, Mg and K:APHA3111B (18th edition) / ASTM D3561

Al: APHA3111D (18th edition)

Ca: FPLL in-house method (FPLL Quality Systems Manual, 1999)

Cation contents were calculated as follows:

$$\text{Cation concentrations (mg/l)} = \frac{C \times Y}{X}$$

Where C = Concentration of Cation determined from calibration curve (mg/l)

Y = Final volume made-up (ml)

X = Volume of sample (ml)

***Heavy Metals in Sediment/soil samples***

Heavy Metals in Sediment samples were determined using ATI Unicam Atomic Absorption Spectrophotometer, Model 939. The sample digestion/preparation procedure followed is described in ASTM D5198/D3974. ASS measurement of heavy metal content sediment samples was done following the procedures indicated below:

Cd, Zn, Mn, Cu, Fe, Ni, and Pb: APHA 3111B (18th edition)

Ba: ASTM D3651

V: APHA 303C (15th edition)

Cr: FPLL in-house method (FPLL Quality Systems Manual, 1999)

Results were calculated as follows:

$$\text{Metal concentration in sample (mg/kg)} = \frac{(A - B) \times C}{D}$$

Where: A = Concentration of metal in sample (mg/l) as determined by AAS

B = Concentration of the metal found in blank (mg/l)

C = Volume of extract (ml)

D = Weight of dry sample (g)

***Heavy Metals in Water Samples***

Heavy metal content of water samples was determined using ATI Unicam Atomic

Absorption Spectrophotometer, Model 939. AAS measurement of heavy metal content sediment samples was done following procedures indicated below:

Cd, Zn, Mn, Cu, Fe, Ni, and Pb: APHA 3111B (18th edition)

Ba: ASTM D3651

V: APHA 303C (15th edition)

Cr: FPLL in-house method (FPLL Quality Systems Manual, 1999)

Results were calculated as follows:

$$\text{Metal concentration (mg/l)} = \frac{C \times Y}{X}$$

Where: C = Concentration of metal from calibration curve (mg/l)

Y = Final volume made-up (ml)

X = Sample volume (ml)

**Recommended Preservatives and Sample Storage Water, Soil and Sediment**

| S/N | PARAMETER | Vol REQD (ML) | CONTAINER | PRESERVATION | MAXIMUM HOLDING PERIOD |
|---|---|---|---|---|---|
| 1 | pH | 35 | P,G | Cool, 4 $^0$C Det. On site | 6 hours |
| 2 | Electrical Conductivity | 100 | P,G | Cool, 4 $^0$C | 24 hours |
| 3 | Colour | 50 | P,G | Cool, 4 $^0$C | 24 hours |
| 4 | Odour | 200 | G, only | Cool, 4 $^0$C | 24 hours |
| 5 | Turbidity | 100 | P,G | Cool, 4 $^0$C | 7 days |
| 6 | Total Dissolved Solids (TDS) | 50 | - | Filter on site cool 4 $^0$C | 24 hours |
| 7 | Total Suspended Solid | 50 | - | Filter on site | 6 months |
| 8 | Total Hardness | 100 | P,G | Cool, 4 $^0$C$HNO_3$ To pH <2 | 7 days |
| 9 | Acidity and alkalinity | 100 | P,G | Cool, 4 $^0$C | 24 hours |
| 10 | Salinity as Cl | 50 | P,G | None required | 7 days |
| 11 | Chemical Oxygen Demand | 50 | P,G | 2ml $H_2SO_4$ per litre | 7 days |
| 12 | Biochemical Oxygen Demand (BOD) | 1,000 | P,G | Refrigeration at 4 $^0$C | 6 hours |
| 13 | Surfactants as (MBAS) | 250 | P,G | Cool, 4 $^0$C | 24 hours |
| 14 | Dissolved Oxygen (DO) | 300 | G, only | Det. On site | No holding |
| 15 | Ammonia | 400 | P,G | Cool, 4 $^0$C $H_2SO_4$ or pH<2 | 24 hours |
| 16 | Oil and Grease | 1,000 | G, only | Cool, 4 $^0$C $H_2SO_4$ or pH<2 | 24 hours |
| 17 | Nitrate $NO_3$ | 100 | P,G | Cool, 4 $^0$C $H_2SO_4$ or pH<2 | 24 hours |
| 18 | Sulphate ($SO_2$/4) | 50 | P,G | Cool, 4 $^0$C | 7 days |
| 19 | Carbonate ($CO_3$) free $CO_2$& $HCO_3$ | - | P,G | - | - |

| S/N | PARAMETER | Vol REQD (ML) | CONTAINER | PRESERVATION | MAXIMUM HOLDING PERIOD |
|---|---|---|---|---|---|
| 20 | Cyanides | 500 | P,G | Cool, 4 $^0$C NaOH to pH 12 | 24 hours |
| 21 | Phosphorous | - | - | 40mg, $HgCL_2$ per litre 4$^0$C | 7 days |
| 22 | Phenolics | 500 | G, only | Cool, 4 $^0$C $H_2SO_4$ or pH< 41.g $CuSO_4$/ litre | 24 hours |
| 23 | Chromium | 100 | P,G | $HNO_3$ to pH<2 | - |
| 24 | Arsenic | 100 | P,G | $HNO_3$ to pH<2 | 6 months |
| 25 | Cadmium | 100 | P,G | $HNO_3$ to pH<2 | 6 months |
| 26 | Cobalt | - | P,G | $HNO_3$ to pH<2 | 6 months |
| 27 | Copper | - | P,G | $HNO_3$ to pH<2 | 6 months |
| 28 | Iron | - | P,G | $HNO_3$ to pH<2 | 6 months |
| 29 | Mercury | 100 | P,G | Filter, $HNO_3$ to pH<2 | 38 days (GLASS) |
| 30 | Lead | 100 | P,G | $HNO_3$ to pH<2 | 6 months |
| 31 | Nickel | 100 | P,G | $HNO_3$ to pH<2 | 6 months |
| 32 | Zinc | 100 | P,G | $HNO_3$ to pH<2 | 6 months |
| 33 | Vanadium | 100 | P,G | $HNO_3$ to pH<2 | 6 months |
| 34 | Calcium | 100 | P,G | None required | 6 months |
| 35 | Magnesium | 100 | P,G | | 6 months |

- P = Plastic, G = Glass

*Source: Environmental Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN). Draft revised Edition Issued by the Department of Petroleum Resources, Lagos 1991 and revised in 2002.*

Note: Table covers water, soil and sediment media.

# APPENDIX D: RESULTS

## APPENDIX D1: RESULTS FOR AMBIENT AIR CONCENTRATIONS AND METEOROLOGY OF THE PROPOSED 500MT LPG BLENDING PLANT PROJECT SITE

| PARAMETER | UNITS | POINT | POINT 2 | POINT 3 | POINT 4 | POINT 5 | POINT 6 | POINT 7 | POINT 8 | POINT 9 | POINT 10 | CONTROL 1 | CONTROL 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Noise | dB[A] | 49.7 | 46.6 | 50.4 | 51.7 | 56.1 | 45.9 | 43.8 | 47.2 | 51,3 | 56.4 | 60.6 | 65.7 |
| SOX | $mg/m^3$ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| NOX | $mg/m^3$ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| CO | $mg/m^3$ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| $NH_3$ | $mg/m^3$ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| $H_2S$ | $mg/m^3$ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| VOC | $mg/m^3$ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| $CO_2$ | $mg/m^3$ | 684 | 693 | 702 | 719 | 752 | 749 | 756 | 696 | 754 | 770 | 730 | 721 |
| $PM_{2.5}$ | $mg/m^3$ | 0.018 | 0.021 | 0.016 | 0.019 | 0.023 | 0.02 | 0.025 | 0.022 | 0.024 | 0.025 | 0.017 | 0.019 |
| $PM_{10}$ | $mg/m^3$ | 0.036 | 0.04 | 0.031 | 0.038 | 0.045 | 0.041 | 0.048 | 0.044 | 0.046 | 0.054 | 0.034 | 0.038 |
| $SO_2$ | $mg/m^3$ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Temp. | °C | 31.4 | 33.2 | 32.1 | 32.8 | 30.9 | 33.3 | 34.7 | 31.9 | 33.5 | 34.1 | 30.7 | 30.4 |
| Wind Speed | m/s | 1.37 | 1.52 | 1.48 | 1.57 | 1.23 | 1.77 | 1.5 | 1.62 | 1.29 | 1.8 | 2.13 | 2.45 |
| Wind Direction | | SW | SE | SW | SW | SE | SE | SW | SE | SW | SW | SW | SW |
| Rel. Humidity | % | 70.9 | 62.8 | 57.9 | 72.5 | 60.7 | 79.2 | 81.8 | 76.6 | 80.4 | 82.6 | 77.5 | 73.9 |

## APPENDIX D2: RESULTS FOR SOIL ANALYSIS (TOP SOIL 0-15CM AND BOTTOM SOIL 15-30CM)

| **Sample ID** | **SS1 T** | **SS1 B** | **SS2 T** | **SS2 B** | **SS3 T** | **SS3 B** | **SS4 T** | **SS4 B** | **SS5 T** | **SS5 B** | **SS6 T** | **SS6 B** | **SS7 T** | **SS7 B** | **SS8 T** | **SS8 B** | **SS9 T** | **SS9 B** | **SS10 T** | **SS10 B** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.27 | 5.38 | 5.56 | 5.44 | 5.4 | 5.32 | 4.94 | 4.83 | 4.58 | 4.26 | 4.37 | 4.13 | 4.44 | 4.37 | 4.21 | 4.6 | 4.52 | 4.36 | 4.21 | 4.1 |
| EC (mS) | 0.083 | 0.079 | 0.048 | 0.032 | 0.028 | 0.022 | 0.019 | 0.014 | 0.026 | 0.018 | 0.032 | 0.026 | 0.016 | 0.012 | 0.036 | 0.028 | 0.025 | 0.017 | 0.068 | 0.059 |
| Sand (%) | 58.3 | 57.2 | 55.9 | 58.7 | 57.6 | 58.5 | 56.3 | 57.2 | 58.1 | 56.7 | 57.4 | 58.5 | 51.8 | 55.2 | 58.6 | 59.2 | 57.4 | 59.1 | 56.9 | 54.8 |
| Silt (%) | 18.3 | 17.5 | 19.6 | 17.8 | 16.9 | 17.1 | 18.2 | 18.3 | 17.8 | 18.6 | 17.3 | 12.9 | 13.4 | 12.7 | 17.5 | 12.3 | 18.2 | 17.6 | 18.5 | 16.8 |
| Clay (%) | 23.4 | 25.3 | 24.5 | 23.5 | 25.5 | 24.4 | 25.5 | 24.5 | 24.1 | 24.7 | 25.3 | 33.6 | 34.8 | 32.1 | 23.9 | 28.5 | 24.4 | 23.3 | 24.6 | 28.4 |
| Bulk Density (g/cm) | 1.28 | 1.32 | 1.54 | 1.62 | 1.46 | 1.53 | 1.37 | 1.28 | 1.34 | 1.16 | 1.21 | 1.56 | 1.61 | 1.38 | 1.45 | 1.27 | 1.33 | 1.22 | 1.34 | 1.19 |
| Textural Class | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam |
| Porosity (%) | 48 | 56 | 58 | 63 | 67 | 56 | 59 | 62 | 65 | 59 | 61 | 50 | 53 | 65 | 68 | 58 | 62 | 67 | 56 | 59 |
| Permeability (cm/s) | 0.09 | 0.06 | 0.12 | 0.09 | 0.05 | 0.03 | 0.02 | 0.23 | 0.2 | 0.31 | 0.28 | 0.19 | 0.15 | 0.12 | 0.1 | 0.05 | 0..23 | 0.32 | 0.04 | 0.02 |
| T.N (%) | 0.56 | 0.42 | 0.34 | 0.28 | 0.19 | 0.11 | 0.07 | 0.91 | 0.87 | 0.75 | 0.64 | 0.53 | 1.67 | 1.58 | 0.82 | 0.77 | 0.52 | 0.46 | 0.62 | 0.55 |
| TOC (%) | 1.31 | 1.24 | 1.08 | 0.98 | 0.62 | 0.49 | 0.39 | 0.28 | 1.23 | 1.13 | 0.75 | 0.64 | 0.51 | 0.39 | 1.17 | 1.2 | 1.04 | 0.82 | 1.08 | 1.03 |
| PO4, mg/kg | 1.42 | 1.35 | 1.68 | 1.53 | 1.25 | 1.16 | 1.81 | 1.75 | 1.64 | 1.46 | 1.21 | 1.42 | 1.38 | 1.96 | 1.58 | 1.87 | 1.13 | 1.31 | 1.58 | 1.64 |
| SO4 mg/kg | 0 | 0 | 0 | 0.16 | 0.12 | 0.07 | 0.03 | 0.11 | 0.08 | 0.05 | 0.02 | 0 | <0.01 | 0 | 0.1 | 0.09 | 0.06 | 0.02 | 0.07 | 0.08 |

| **Sample ID** | **SS1 T** | **SS1 B** | **SS2 T** | **SS2 B** | **SS3 T** | **SS3 B** | **SS4 T** | **SS4 B** | **SS5 T** | **SS5 B** | **SS6 T** | **SS6 B** | **SS7 T** | **SS7 B** | **SS8 T** | **SS8 B** | **SS9 T** | **SS9 B** | **SS10 T** | **SS10 B** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO3 mg/kg | 1.29 | 1.18 | 2.16 | 2.09 | 1.91 | 1.73 | 2.74 | 2.51 | 2.31 | 2.24 | 1.76 | 1.58 | 1.13 | 1.05 | 1.36 | 2.41 | 1.73 | 1.6 | 2.45 | 2.31 |
| NO2 mg/kg | 4.58 | 3.42 | 3.61 | 3.32 | 2.95 | 2.42 | 3.53 | 3.28 | 5.72 | 4.18 | 3.85 | 2.39 | 2.84 | 2.15 | 2.28 | 3.32 | 2.42 | 3.13 | 3.32 | 2.64 |
| THC mg/kg | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 |
| TPH mg/kg | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 |
| Zn mg/kg | 29.564 | 27.351 | 23.926 | 18.768 | 30.612 | 26.843 | 32.876 | 28.541 | 27.543 | 24.213 | 21.903 | 18.654 | 23.752 | 19.513 | 31.367 | 29.109 | 17.253 | 13.765 | 11.216 | 8.273 |
| BTEX, mg/kg | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 |
| THB cfu/g×107 | 0.66 | 0.49 | 0.57 | 0.52 | 0.38 | 0.63 | 0.58 | 0.47 | 0 | 0.55 | 0.49 | 0 | 0 | 0.61 | 0.55 | 0.4 | 0 | 0 | 0 | 0.46 |
| THF cfu/g×103 | 1.23 | 1.05 | 1.27 | 1.19 | 1.04 | 1.36 | 1.19 | 1.14 | 0.99 | 1.21 | 1.12 | 1.01 | 0.84 | 1.25 | 1.07 | 1.06 | 0.98 | 1.03 | 0.81 | 1.12 |
| HUB cfu/g×105 | 0.16 | 0..12 | 0.28 | 0.22 | 0 | 0.27 | 0.25 | 0.2 | 0 | 0.24 | 0.21 | ND | 0 | 0.26 | 0 | 0.17 | 0 | ND | 0 | 0.25 |
| HUF cfu/g×102 | 2.54 | 2.38 | 2.7 | 2.61 | 2.96 | 2.83 | 2.59 | 2.4 | 2.16 | 2.64 | 2.43 | 2.2 | 1.83 | 2.71 | 2.34 | 2.3 | 2.09 | 2.24 | 1.77 | 2.39 |
| Fe mg/kg | 589.321 | 536.258 | 609.342 | 582.109 | 487.452 | 395.678 | 393.215 | 374.628 | 575.096 | 453.187 | 628.341 | 567.568 | 781.543 | 659.376 | 398.541 | 277.682 | 558.187 | 462.376 | 503.941 | 421.658 |

| **Sample ID** | **SS1 T** | **SS1 B** | **SS2 T** | **SS2 B** | **SS3 T** | **SS3 B** | **SS4 T** | **SS4 B** | **SS5 T** | **SS5 B** | **SS6 T** | **SS6 B** | **SS7 T** | **SS7 B** | **SS8 T** | **SS8 B** | **SS9 T** | **SS9 B** | **SS10 T** | **SS10 B** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cd mg/kg | 0.139 | 0.127 | 0.146 | 0.132 | 0.121 | 0.116 | 0.157 | 0.143 | 0.213 | 0.206 | 0.132 | 0.124 | 0.256 | 0.212 | 0.113 | 0.105 | 0.246 | 0.235 | 0.261 | 0.252 |
| Cr mg/kg | 2.596 | 2.105 | 1.487 | 1.265 | 4.188 | 3.256 | 1.078 | 0.856 | 3.413 | 2.732 | 2.986 | 1.834 | 2.866 | 1.932 | 1.533 | 1.178 | 3.43 | 2.687 | 1.778 | 1.415 |
| Ni mg/kg | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 |
| V mg/kg | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 |
| Pb mg/kg | 0.182 | 0.166 | 0.283 | 0.254 | 0.139 | 0.124 | 0.115 | 0.109 | 0.194 | 0.182 | 0.136 | 0.121 | 0.145 | 0.136 | 0.21 | 0.203 | 0.176 | 0.158 | 0.142 | 0.133 |
| Ba mg/kg | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 |
| Hg mg/kg | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 | <0.001 | 0 |

## APENDIX D5: RESULT FOR GROUND WATER OF THE PROPOSED PROJECT AREA

| PARAMETERS | UNITS | BH 1 | BH 2 | BH CONTROL |
|---|---|---|---|---|
| pH | | 4.10 | 5.13 | 5.34 |
| Temperature | $^{o}C$ | 30.2 | 30.1 | 29.7 |
| TDS | mg/l | 34.50 | 21.46 | 6.38 |
| EC | µS/cm | 66.73 | 42.51 | 12.40 |
| Colour | LCU | 2.00 | 2.00 | 1.00 |
| Turbidity | NTU | 0.36 | 0.28 | 0.19 |
| TSS | mg/l | 6.00 | 5.00 | 3.00 |
| Total Hardness | mg/l | 5.88 | 3.92 | 1.42 |
| DO | mg/l | 5.20 | 5.40 | 5.50 |
| BOD | mg/l | 1.20 | 0.90 | 0.70 |
| COD | mg/l | 2.80 | 2.10 | 1.63 |
| Chloride | mg/l | 4.686 | 3.749 | 1.406 |
| Salinity | mg/l | 8.744 | 6.995 | 2.623 |
| Nitrate | mg/l | <0.01 | <0.01 | <0.01 |
| Nitrite | mg/l | <0.01 | <0.01 | <0.01 |
| $SO_4^{2-}$ | mg/l | 0.25 | 0.13 | 0.09 |
| $PO_4^{3}$ | mg/l | <0.01 | <0.01 | <0.01 |
| $NH_4$ | mg/l | <0.01 | <0.01 | <0.01 |
| Na | mg/l | 1.13 | 1.09 | 1.24 |
| K | mg/l | 0.05 | 0.07 | 0.03 |
| Ca | mg/l | 1.435 | 0.894 | 0.313 |
| Mg | mg/l | 0.560 | 0.412 | 0.156 |
| TPH | mg/l | <0.001 | <0.001 | <0.001 |
| BTEX | mg/l | <0.001 | <0.001 | <0.001 |
| THC | mg/l | <0.001 | <0.001 | <0.001 |
| Total Coliform Count | MPN/100ml | 11.00 | 7.00 | 4.00 |
| Feacal Coliform Count | MPN/100ml | ND | ND | ND |
| Fe | mg/l | 0.043 | 0.032 | 0.012 |

| PARAMETERS | UNITS | BH 1 | BH 2 | BH CONTROL |
|---|---|---|---|---|
| Zn | mg/l | 0.026 | 0.017 | 0.008 |
| Pb | mg/l | <0.001 | <0.001 | <0.001 |
| Cd | mg/l | <0.001 | <0.001 | <0.001 |
| Cr | mg/l | <0.001 | <0.001 | <0.001 |
| Ni | mg/l | <0.001 | <0.001 | <0.001 |
| V | mg/l | <0.001 | <0.001 | <0.001 |
| Hg | mg/l | <0.001 | <0.001 | <0.001 |
| Ba | mg/l | <0.001 | <0.001 | <0.001 |
| Mn | mg/l | <0.001 | <0.001 | <0.001 |

# APPENDIX E: QUESTIONNAIRE ON SOCIO-ECONOMICS AND COMMUNITY HEALTH SURVEY USED IN THIS STUDY

## SOCIOECONOMIC AND COMMUNITY HEALTH QUESTIONNAIRE

**ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN**

**PROPOSED 500MT MINI LNG BLENDING DEPOT AT UMUOBIEGWUTU FAMILY LAND, IDUMUOBI-OGALAWA ETITI, OGBEOWELE QUARTERS, IBUSA, OSHIMILI NORTH LGA, DELTA STATE**

**Project Proponent: Rainoil Limited**

| | | | |
|---|---|---|---|
| **Questionnaire ID** | ____________ | **Date** | _____/_____/ 2026 |
| **Community/Quarter** | ____________ | **Enumerator ID** | ____________ |
| **Distance from Site** | ☐ <250m ☐ 250–499m ☐ 500–999m ☐ 1–2km ☐ >2km | **Interview Status** | ☐ Complete ☐ Partial ☐ Refused |

### INFORMED CONSENT

This survey supports the Environmental and Social Management Plan for the proposed project. Participation is voluntary. Responses will be confidential and used only for environmental, social and health assessment. Participation does not guarantee employment, compensation or any financial benefit.

**C0.** Do you voluntarily agree to participate?

☐ 1 Yes ☐ 2 No - End interview

### SECTION A: RESPONDENT AND HOUSEHOLD PROFILE

**A1.** Relationship to household head

☐ 1 Head ☐ 2 Spouse ☐ 3 Child ☐ 4 Relative ☐ 5 Non-relative ☐ 6 Other

**A2.** Sex

☐ 1 Male ☐ 2 Female ☐ 3 Prefer not to state

**A3.** Age in completed years: ________

**A4.** Marital status

☐ 1 Never married ☐ 2 Married ☐ 3 Separated/Divorced ☐ 4 Widowed ☐ 5 Other

**A5.** Highest education completed

☐ 0 None ☐ 1 Primary ☐ 2 Secondary ☐ 3 Vocational/Technical ☐ 4 ND/NCE ☐ 5 HND/Degree ☐ 6 Postgraduate

**A6.** Employment status

☐ 1 Full-time ☐ 2 Part-time ☐ 3 Self-employed ☐ 4 Casual ☐ 5 Student ☐ 6 Unemployed ☐ 7 Retired ☐ 8 Other

**A7.** Main occupation

☐ 1 Farming ☐ 2 Trading ☐ 3 Artisan ☐ 4 Transport ☐ 5 Civil/Public Service ☐ 6 Private Sector ☐ 7 Oil/Gas Services ☐ 8 Other

**A8.** Years resident in this community

☐ 1 <1 ☐ 2 1–5 ☐ 3 6–10 ☐ 4 11–20 ☐ 5 >20 ☐ 6 Since birth

**A9.** Household size: 0–4 yrs ___ 5–17 yrs ___ 18–59 yrs ___ 60+ yrs ___ Total ___

**A10.** Any household member with disability or long-term functional limitation?

☐ 1 Yes ☐ 2 No ☐ 88 Don't know

### SECTION B: HOUSING, LAND AND BASIC SERVICES

**B1.** Type of dwelling

☐ 1 Detached ☐ 2 Semi-detached ☐ 3 Flat ☐ 4 Room/Compound ☐ 5 Traditional ☐ 6 Other

**B2.** Housing tenure

☐ 1 Owner ☐ 2 Rented ☐ 3 Family-owned ☐ 4 Employer-provided ☐ 5 Other

**B3.** Main surrounding land use

☐ 1 Residential ☐ 2 Commercial ☐ 3 Agricultural ☐ 4 Industrial ☐ 5 Institutional ☐ 6 Mixed ☐ 7 Undeveloped

**B4.** Does the household own or use land within the project area of influence?

☐ 1 Yes ☐ 2 No ☐ 88 Don't know

**B5.** Main land interest/use

☐ 1 Family/Customary ownership ☐ 2 Registered ownership ☐ 3 Lease/Tenancy ☐ 4 Farming ☐ 5 Business ☐ 6 Other

**B6.** Are there known land or boundary disputes near the project area?
☐ 1 Yes ☐ 2 No ☐ 88 Don't know

**B7.** Main drinking-water source
☐ 1 Private borehole ☐ 2 Public borehole ☐ 3 Well ☐ 4 Sachet/Bottled ☐ 5 Vendor/Tanker ☐ 6 Other

**B8.** Main toilet facility
☐ 1 Water closet ☐ 2 Improved pit ☐ 3 Ordinary pit ☐ 4 Public/shared ☐ 5 Open defecation ☐ 6 Other

**B9.** Main waste-disposal method
☐ 1 Collector ☐ 2 Collection point ☐ 3 Burning ☐ 4 Open dumping ☐ 5 Burial ☐ 6 Other

**B10.** Main electricity source
☐ 1 Public supply ☐ 2 Generator ☐ 3 Solar ☐ 4 Mixed sources ☐ 5 None

**For B11, tick one response per row: 1=Very Poor, 2=Poor, 3=Fair, 4=Good, 5=Very Good, 88=Don't Know.**

| Code | Item | Response |
|---|---|---|
| B11a | Access roads | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| B11b | Drainage | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| B11c | Electricity | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| B11d | Water supply | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| B11e | Waste services | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| B11f | Healthcare | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| B11g | Security | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| B11h | Fire/emergency response | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |

## SECTION C: LIVELIHOOD AND HOUSEHOLD ECONOMY

**C1.** Number of economically active household members: ___ Number unemployed and seeking work: ___

**C2.** Average monthly household income
☐ 1 <₦50,000 ☐ 2 ₦50,000–₦99,999 ☐ 3 ₦100,000–₦199,999 ☐ 4 ₦200,000–₦499,999 ☐ 5 ≥₦500,000
☐ 99 No response

**C3.** Compared with three years ago, household economic condition is
☐ 1 Much better ☐ 2 Better ☐ 3 Same ☐ 4 Worse ☐ 5 Much worse

**C4.** Does the household operate a business in the community?
☐ 1 Yes ☐ 2 No

**C5.** Three main livelihood challenges - tick up to three
☐ 1 Unemployment ☐ 2 Low income ☐ 3 Poor roads ☐ 4 Poor electricity ☐ 5 Limited finance ☐ 6 Flooding ☐ 7 Pollution ☐ 8 Insecurity ☐ 9 Other

## SECTION D: ENVIRONMENTAL CONDITIONS AND TRAFFIC

**D1.** Overall environmental quality
☐ 1 Very poor ☐ 2 Poor ☐ 3 Fair ☐ 4 Good ☐ 5 Very good

**D2.** Existing environmental problems - tick all that apply
☐ 0 None ☐ 1 Dust ☐ 2 Smoke/Fumes ☐ 3 Odour ☐ 4 Noise ☐ 5 Flooding ☐ 6 Poor waste disposal
☐ 7 Water pollution ☐ 8 Traffic ☐ 9 Vegetation loss ☐ 10 Other

**D3.** How often is disturbing noise experienced?
☐ 1 Daily ☐ 2 Several times weekly ☐ 3 Occasionally ☐ 4 Rarely ☐ 5 Never

**D4.** Traffic condition around the project area
☐ 1 Very light ☐ 2 Light ☐ 3 Moderate ☐ 4 Heavy ☐ 5 Very heavy

**D5.** Concern about tanker/heavy-duty vehicle movements
☐ 1 Not concerned ☐ 2 Slightly ☐ 3 Moderately ☐ 4 Very ☐ 5 Extremely

**D6.** Main road-safety problems - tick all that apply

☐ 0 None ☐ 1 Poor road ☐ 2 Narrow road ☐ 3 No walkway ☐ 4 Poor lighting ☐ 5 Speeding ☐ 6 Heavy trucks ☐ 7 Poor signs ☐ 8 Flooded road ☐ 9 Other

## SECTION E: COMMUNITY HEALTH

**E1.** How would you rate your current health?

☐ 1 Very poor ☐ 2 Poor ☐ 3 Fair ☐ 4 Good ☐ 5 Very good

**E2.** Has any household member been ill in the last four weeks?

☐ 1 Yes ☐ 2 No ☐ 88 Don't know

**E3.** Symptoms/illnesses in the last four weeks - tick all that apply

☐ 0 None ☐ 1 Fever/Malaria-like ☐ 2 Cough ☐ 3 Breathing difficulty ☐ 4 Eye/Skin irritation ☐ 5 Headache/Dizziness ☐ 6 Nausea/Diarrhoea ☐ 7 Sleep disturbance ☐ 8 Stress/Anxiety ☐ 9 Injury ☐ 10 Other

**E4.** Was treatment sought?

☐ 1 Health facility ☐ 2 Pharmacy/Self-medication ☐ 3 Traditional/Religious ☐ 4 No treatment ☐ 5 Not applicable

**E5.** Any professionally diagnosed condition in the household? - tick all that apply

☐ 0 None ☐ 1 Asthma/Respiratory ☐ 2 Hypertension/Heart disease ☐ 3 Diabetes ☐ 4 Skin condition ☐ 5 Hearing/Eye disorder ☐ 6 Disability ☐ 7 Other ☐ 88 Don't know

**E6.** Vulnerable household members - tick all that apply

☐ 0 None ☐ 1 Under-five children ☐ 2 Pregnant women ☐ 3 Elderly ☐ 4 Persons with disability ☐ 5 Respiratory/Cardiac patients ☐ 6 Other

**For E7, tick one response per row: 0=Never, 1=Rarely, 2=Sometimes, 3=Often, 4=Almost Daily, 88=Don't Know.**

| Code | Health symptom/condition | Response |
|---|---|---|
| E7a | Persistent cough | ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 88 |
| E7b | Breathing difficulty/wheezing | ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 88 |
| E7c | Eye, nose or throat irritation | ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 88 |
| E7d | Headache/dizziness linked to fumes | ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 88 |
| E7e | Sleep disturbance from noise | ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 88 |
| E7f | Anxiety about fire, gas leak or explosion | ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 88 |

**E8.** Any suspected water-related illness in the last six months?

☐ 1 Yes ☐ 2 No ☐ 88 Don't know

**E9.** Travel time to nearest functional health facility

☐ 1 <15 min ☐ 2 15–30 min ☐ 3 31–60 min ☐ 4 >60 min ☐ 88 Don't know

**E10.** Confidence in local response to major fire, gas leak or explosion

☐ 1 None ☐ 2 Low ☐ 3 Moderate ☐ 4 High ☐ 5 Very high ☐ 88 Don't know

## SECTION F: PROJECT AWARENESS, BENEFITS AND CONCERNS

**F1.** Were you aware of the proposed project before this interview?

☐ 1 Yes ☐ 2 No

**F2.** Expected project benefits - tick all that apply

☐ 0 None ☐ 1 Employment ☐ 2 Business opportunities ☐ 3 Road improvement ☐ 4 Local revenue ☐ 5 Skills training ☐ 6 Community projects ☐ 7 Other

**F3.** Main concerns - tick all that apply

☐ 0 None ☐ 1 Fire/Explosion ☐ 2 Gas leakage ☐ 3 Air pollution/Odour ☐ 4 Noise ☐ 5 Traffic/Accidents ☐ 6 Water/Soil pollution ☐ 7 Land/Compensation ☐ 8 Worker influx/Security ☐ 9 Poor consultation ☐ 10 Other

**F4.** Overall position on the project

☐ 1 Strongly support ☐ 2 Support ☐ 3 Neutral ☐ 4 Oppose ☐ 5 Strongly oppose ☐ 88 Undecided

**For F5, tick one response per row: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree, 88=Don't Know.**

| Code | Item | Response |
|---|---|---|
| F5a | The project will create local employment. | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| F5b | The project may increase traffic and road-safety risks. | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| F5c | The project may affect air quality or noise levels. | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| F5d | Fire, gas-leak and explosion risks require strong controls. | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| F5e | Community representatives should participate in monitoring. | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| F5f | A transparent grievance mechanism is necessary. | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |

## SECTION G: STAKEHOLDER ENGAGEMENT AND GRIEVANCE MANAGEMENT

**G1.** Has your household participated in any project consultation?

☐ 1 Yes ☐ 2 No ☐ 88 Don't know

**G2.** Preferred channels for project information - tick up to three

☐ 1 Community meetings ☐ 2 Traditional leaders ☐ 3 Printed notices ☐ 4 Radio ☐ 5 SMS/Phone ☐ 6 WhatsApp/Social media ☐ 7 Liaison office ☐ 8 Other

**G3.** Preferred grievance channel

☐ 1 Community Liaison Officer ☐ 2 Written complaint ☐ 3 Phone/WhatsApp ☐ 4 Community leader ☐ 5 Complaint box ☐ 6 Government agency ☐ 7 Other

**G4.** Reasonable time to acknowledge a complaint

☐ 1 24 hours ☐ 2 3 working days ☐ 3 7 working days ☐ 4 14 working days

**G5.** Should confidential or anonymous complaints be accepted?

☐ 1 Yes ☐ 2 No ☐ 88 Don't know

## SECTION H: COMMUNITY PRIORITIES AND ESMP MEASURES

**H1.** Select and rank the five highest community priorities (1=highest):
*Write rank beside each selected option.*

| Code | Priority | Rank |
|---|---|---|
| ☐ 1 | Employment | ___ |
| ☐ 2 | Skills training | ___ |
| ☐ 3 | Roads | ___ |
| ☐ 4 | Drainage/Flood control | ___ |
| ☐ 5 | Water supply | ___ |
| ☐ 6 | Electricity | ___ |
| ☐ 7 | Healthcare | ___ |
| ☐ 8 | Education | ___ |
| ☐ 9 | Youth/Women support | ___ |
| ☐ 10 | Waste management | ___ |
| ☐ 11 | Fire/Emergency services | ___ |
| ☐ 12 | Security | ___ |

**For H2, rate each ESMP measure: 1=Not Important, 2=Slightly Important, 3=Moderately Important, 4=Very Important, 5=Essential, 88=Don't Know.**

| Code | Item | Response |
|---|---|---|
| H2a | Emergency response plan for gas leaks, fire and explosion | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2b | Fire detection, suppression and evacuation drills | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2c | Air, noise, soil and groundwater monitoring | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2d | Spill prevention and waste-management procedures | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2e | Traffic plan, tanker routes and speed control | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2f | Local employment and procurement plan | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2g | Worker code of conduct and occupational safety | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2h | Community health and safety plan | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2i | Stakeholder engagement and grievance mechanism | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |
| H2j | Disclosure of monitoring results | ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 88 |

### SECTION I: FINAL COMMENTS

**I1.** Greatest project concern:

______________________________________________

______________________________________________

**I2.** Most important expected benefit:

______________________________________________

______________________________________________

**I3.** Most important action to protect community health and safety:

______________________________________________

______________________________________________

**I4.** Additional recommendation:

______________________________________________

______________________________________________

### ENUMERATOR OBSERVATION

| Code | Observation | Tick One |
|---|---|---|
| O1 | Dwelling condition | ☐ Poor ☐ Fair ☐ Good ☐ Very good |
| O2 | Drainage | ☐ Functional ☐ Blocked ☐ None |
| O3 | Waste accumulation | ☐ None ☐ Low ☐ Moderate ☐ High |
| O4 | Traffic at survey time | ☐ Light ☐ Moderate ☐ Heavy |
| O5 | Noticeable noise/fumes | ☐ None ☐ Low ☐ Moderate ☐ High |
| O6 | Response reliability | ☐ High ☐ Moderate ☐ Low |

### CODING AND QUALITY-CONTROL NOTES

- Use 88 for Don't Know, 99 for No Response, and 97 for Not Applicable where required.
- For "tick all that apply" questions, enter each option as a separate binary variable: 0=Not selected; 1=Selected.
- Pre-test the questionnaire before full deployment and train enumerators on consent, confidentiality, neutrality and skip instructions.
- Disaggregate results, where sample size permits, by sex, age, income, vulnerability status, community and distance from the project site.