ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF THE PROPOSED LPG REFILLING PLANT, OPPOSITE AIR PORT, BIRNIN KEBBI ROAD, BODINGA LGA, SOKOTO STATE

BY

ZAMSON GLOBAL RESOURCES LIMITED

CONSULTANTS:

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SUBMITTED TO:

FEDERAL MINISTRY OF ENVIRONMENT

FEDERAL MINISTRY OF ENVIRONMENT

MARCH 2026

DECLARATION

Zamson Global Resources Limited hereby affirms that the Environmental Impact Assessment (EIA) Report for the proposed Liquefied Petroleum Gas (LPG) Refilling Plant located opposite the Airport along Birnin Kebbi Road, Bodinga Local Government Area of Sokoto State, has been prepared in accordance with established scientific principles, relevant regulatory guidelines, and best professional practices.

The Company accepts full responsibility for the effective implementation of the Environmental Management Plan (EMP) as outlined in this report. Zamson Global Resources Limited is committed to ensuring the protection and sustainability of the biophysical and socio-economic environment within and around the project area, in full compliance with all applicable environmental laws, regulations, and standards of the Federal Ministry of Environment, as well as other relevant authorities in Sokoto State.

Furthermore, the Company undertakes to adopt proactive environmental management strategies, including continuous monitoring, risk mitigation, and stakeholder engagement, to ensure that all project activities are conducted in an environmentally sound and socially responsible manner throughout the project lifecycle.

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ABBREVIATION

AQ	Air Quality (Sample Station)
ALARP	As Low As Reasonable Practicable
ASTM	American Society for Testing Materials
CDC	Community Developments Committee
CH4	Methane
Ca	Calcium
CBO	Community Based Organization
Cd	Cadmium
Cfu/g	Colony Forming Unit Per Gram
Cfu/ml	Colony Forming Unit Per Mililiter
CO	Carbon monozide
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
Cr	Chromium
Cu	Copper
CRA	Child Rights Act
dBA	Decibels
DEC	Diehylcarbamazine
DO	Dissolved Oxygen
DPR	Department of Petroleum Resources
EAP	Emergency Action Plan
EPC	Engineering, Procurement Construction
EAR	Environmental Audit Report
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
E&R	Environmental & Regulatory
ERP	Emergency Response Plan
Fe	Iron
FEPA	Federal Environmental Protection Agency
FEED	Front End Engineering Design
FGDs	Focus Group Discussions
FMEnv	Federal Ministry of Environment
GHG	Green House Gases
GIIP	Good International Industry Practice
GPS	Global Positioning System
Gpm	Gallons per Minute
GSA	Gas Supply Agreement
HB	Heterotrophic Bacteria
HNO3	Nitric Acid
H2S	Hydrogen Sulphide
HSE	Health, Safety and Environment
H2SO4	Tetraoxosulphate VI Acid

HUB	Hydrocarbon Utilizing Bacteria
HUF	Hydrocarbon Utilizing Fungi
IFC	IUCN International Finance Corporation International Union for Conservation of Nature
ISO	International Organization for Standardization
JSA	Job Safety Analysis
K	Potassium
SSEPA	Sokoto State Environmental Protection Agency
KWHr	Kilowatt per hour
Leq	Equivalent Continuous Noise Level
LGA	Local Government Area
LGC	Local Government Council
LPG	Liquefied Petroleum Gas
MSL	Mean Sea Level
MSDS	Material Safety Data Sheets
Mg	Magnesium
Mg/Kg	Milligram per Kilogram
Mg/l	Milligram per Liter
mmHg	Millimeter Mercury
MoU	Memorandum of Understanding
MW	Megawatt
Na	Sodium
NBS	National Bureau of Statistics
NESREA	National Environmental Standards and Regulations Enforcement Agency
NPC	National Population Commission
NO2	Nitrogen IV Oxide
NOx	Nitrogen Oxides
Ni	Nickel
NIMET	Nigeria Meterological Agency
NPC	National Population Commission
NTU	Nephelometric Turbidity Units
PAH	Poly-Aromatic Hydrocarbon
Pb	Lead
Ph	Hydrogen ion Concentration
PM	Project Manager
PMT	Project Management Team
PPE	Personal Protective Equipment
Ppm	Part Per Million
ppmv	Parts per million volume
PS	Performance Standard
QC	Quality Control
RAM	Risk Assessment Matrix
RCP	Regulatory Compliance Plan
RTA	Road Traffic Accident

SEP	Stakeholders Engagement Plan
SO4	Sulphate
SO2	Sulphur IV Oxide
SPM	Suspended Particulate Matter
STD	Sexually Transmitted Diseases
SOP	Standard Operating Procedure
SSHE	Security, Safety, Health and Environment
SQC	Statistical Quality Checking
TDS	Total Dissolved Solid
TFR	Total Fertility Rate
THB	Total Heterotrophic Bacteria
THC	Total Hydrocarbon Content
THF	Total Heterotrophic Fungi
THFC	Total Heterotrophic Fungal Count
TOC	Total Organic Content
ToR	Terms of Reference
TSS	Total Suspended Solid
UN	United Nations
VOC	Volatile Organic Content
V	Vanadium
VOCS	Volatile Organic Compounds
VGT	Vegetation Transect
WCD	World Commission on Dams
WBG	World Bank Group
WHO	World Health Organization
Zn	Zinc

%	Percent
OC	Degree Celsius
µ	Micron
=	Equal to
<	Less Than
>	Greater than

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EXECUTIVE SUMMARY

ES1: Introduction and Project Background

Zamson Global Resources Limited (ZAGR), an indigenous energy company committed to promoting clean and efficient energy solutions in Nigeria, proposes to establish a modern modular Liquefied Petroleum Gas (LPG) storage and refilling plant with a bulk storage capacity of two hundred (200) metric tons. The proposed facility will be located opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State. The project is designed to enhance the availability, accessibility, and affordability of LPG for domestic, commercial, and industrial consumers within Sokoto metropolis and its surrounding communities.

The proposed facility will operate as a bulk LPG storage and cylinder refilling plant, equipped with eight (08) electronically controlled refilling machines. These units will be configured to dispense LPG into 6 kg, 12 kg, 25 kg, and 35 kg cylinders primarily for household use, while also accommodating larger cylinder sizes for industrial and commercial applications. The bulk storage tank will contain LPG, a pressurized mixture of propane and butane, which are liquefied hydrocarbon products obtained from natural gas processing and associated petroleum operations.

ZAGR is an established operator in Nigeria's natural gas sector, with experience in LPG infrastructure, distribution, and vehicle conversion technologies. The company is committed to sustainable development, occupational health and safety, and reducing Nigeria's carbon footprint.

To ensure environmental sustainability, ZAGR has initiated this Environmental Impact Assessment (EIA) in line with the EIA Act CAP E12 LFN 2004. The assessment identifies potential environmental and social impacts of the proposed LPG project and recommends mitigation and management strategies across all phases: pre-construction, construction, operation, and decommissioning. The study includes biophysical, socio-economic, and health assessments, using field sampling, laboratory analyses, stakeholder consultations, and literature reviews of similar projects in Sokoto State.

The regulatory framework governing the project includes national laws such as the Environmental Impact Assessment Act, the Petroleum Industry Act 2021, NESREA regulations, the Land Use Act, the Labour Act, and relevant international conventions on biodiversity, climate change, hazardous waste, and occupational health and safety. At the state level, compliance will follow Sokoto State Environmental Protection Agency (KASEPA) guidelines and local government directives to ensure environmental protection, community welfare, and orderly land use.

This EIA report is structured into nine chapters, covering the project description, environmental baseline studies, impact assessment, mitigation measures, environmental management plans, decommissioning strategies, and concluding with recommendations to support responsible project implementation.

ES2: Project Justification

The proposed 200 metric tons Liquefied Petroleum Gas (LPG) Storage and Refilling Plant by Zamson Global Resources Limited, to be sited opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State, is intended to address the increasing demand for reliable and cleaner energy solutions within Sokoto metropolis and surrounding communities. The project aligns with Nigeria's strategic objectives of promoting domestic gas utilization as a means of achieving energy security, environmental sustainability, and long-term economic development.

Although Nigeria possesses significant natural gas resources, access to LPG in many northern states, including Sokoto, remains limited due to insufficient storage and distribution infrastructure. Consequently, households and small enterprises continue to rely heavily on firewood, kerosene, and other carbon-intensive fuels. The establishment of a bulk LPG facility in Bodinga is expected to strengthen the downstream gas supply chain, enhance product availability, and provide a regulated, safe platform for storage and cylinder refilling.

Sokoto State is experiencing steady urban expansion and increasing commercial activities, particularly along key transport corridors such as Birnin Kebbi Road, resulting in rising energy demands across residential, commercial, and light industrial sectors. The proposed LPG plant will help stabilize supply, minimize transportation constraints from distant depots, and reduce unsafe informal refilling operations that pose significant safety hazards to the public.

Environmentally, LPG use reduces emissions of nitrogen oxides, particulate matter, and greenhouse gases, contributing to Nigeria's commitments under the Paris Agreement. By substituting polluting fuels with LPG, the project alleviates pressure on forests and promotes sustainable development. Socially, the project enhances community welfare through local engagement, equitable employment opportunities, and the adoption of grievance mechanisms and corporate social responsibility programs.

Sustainability is embedded in the project's design across economic, environmental, technical, and social dimensions. Economically, growing regional demand and government support ensure commercial viability. Environmentally, mitigation measures, leak detection systems, and the EIA framework guide safe and low-impact operations. Technically, modern storage and dispensing systems will comply with national and international safety standards, incorporating redundancy and maintenance regimes to ensure reliability. Socially, the project fosters community development, stakeholder participation, and health and safety programs.

Alternative options, including "do-nothing," were considered but rejected for failing to address energy needs or environmental challenges. Birnin Kebbi Road was selected for its strategic location, land availability, and community acceptance, while above-ground storage and semi-automated dispensing technologies were chosen to maximize operational efficiency, safety, and adaptability.

ES3: Project Description and Scope

The proposed project by Zamson Global Resources Limited entails the development of a modern Liquefied Petroleum Gas (LPG) Storage and Refilling Plant along Birnin Kebbi Road, Bodinga Local Government Area, Sokoto State. The initiative aligns with the Federal Government's National Gas Expansion Programme (NGEP), which seeks to transition Nigeria from conventional petroleum fuels to cleaner, safer, and more sustainable energy sources. The project is designed to meet the growing demand for affordable and environmentally friendly energy in Sokoto State and the broader northern region, particularly for domestic, commercial, and vehicular applications.

The facility, spanning approximately 10,000 square meters, will function as a primary LPG hub for storage, compression, and distribution. LPG will be delivered to the site via road tankers and compressed using high-pressure systems for direct refueling of vehicles as well as for onward loading into distribution trucks serving satellite stations. This arrangement will improve fuel availability, reduce reliance on petrol and diesel, support the adoption of LPG-powered vehicles, enhance air quality, and comply with national safety and environmental regulations.

Key infrastructure components include high-pressure storage vessels certified to ISO standards, with a combined capacity of 200 metric tons, and gas compressor units capable of pressurizing LPG for safe dispensing and onward distribution. Safety features such as pressure relief valves, emergency shutdown systems, and automated monitoring are integrated to ensure efficient and secure operations.

The dispensing and metering system comprises dedicated refueling bays equipped with leak-proof high-pressure hoses, double nozzles for simultaneous vehicle fueling, and automated meters to guarantee accurate measurement and billing. Operational control is maintained via pressure regulators, automatic shut-off valves, and a programmable logic control (PLC) panel for real-time monitoring and management.

Fire protection and safety measures are embedded throughout the facility, including strategically placed fire hydrants and extinguishers, gas detection and alarm systems, emergency assembly points, and perimeter fencing with controlled access to enhance both safety and security.

Ancillary infrastructure will support operational efficiency and staff welfare. This includes an administrative block with offices, a control room, and staff facilities, a reliable power supply through both grid connection and backup generator, an on-site borehole for water supply, and a drainage network to manage wastewater and stormwater. Paved access roads, reinforced forecourts, adequate lighting, and safety signage will facilitate smooth vehicle circulation and operational effectiveness.

The project is designed for a 30-year operational lifespan, with construction anticipated to take up to 12 months after permit approvals. It integrates advanced storage, processing, safety, and utility systems within an organized site layout to ensure operational efficiency, risk mitigation, and compliance with national and international standards.

ES4: Current Environmental Conditions at the Project Area

The baseline environmental study for the proposed Liquefied Petroleum Gas (LPG) station located along Birnin Kebbi Road in Sokoto State was carried out using multiple research approaches, including field investigations, laboratory testing, review of existing literature, and consultations with local communities. Data gathering was conducted during the rainy season and involved both primary observations from the project site and secondary information obtained from nearby locations within the Sudan Savannah ecological zone. This approach provided a dependable understanding of the prevailing physical, biological, and socio-economic conditions of the area.

The adopted methodology ensured that key environmental components such as air quality, water resources, soil characteristics, vegetation, wildlife, and public health conditions were adequately assessed. As a result, the baseline information generated serves as an important benchmark for assessing potential environmental and social impacts associated with the proposed LPG development.

The proposed project is situated within the Sudan Savannah ecological zone of northern Nigeria. The area experiences a tropical continental climate characterized by two distinct seasons: the wet season, which spans from May to September, and the dry season, which lasts from October to April. During the months of March to May, daytime temperatures typically range between 40°C and 44°C, occasionally peaking above 45°C. In contrast, mornings during the harmattan season of December and January may experience temperatures as low as 15°C to 18°C, while afternoons remain warm. The mean annual temperature in the area generally falls between 28°C and 32°C. These high temperatures are important for the safe handling and storage of LPG, as elevated heat increases vapour pressure in tanks and cylinders. To mitigate this risk, the facility design will include pressure relief valves, appropriate tank spacing, heat-resistant materials, adequate ventilation, and work-rest protocols for personnel to prevent heat-related occupational hazards.. Relative humidity during this period typically ranges between 60% and 70%, contributing to moist atmospheric conditions.

Wind patterns in the project area are seasonal in nature. Northeasterly winds dominate during the dry season, largely influenced by the Harmattan air mass, while southwesterly winds prevail during the wet season. These wind dynamics play an important role in the natural dispersion of gaseous emissions, which is particularly relevant to the proposed LPG facility in terms of air quality management and safety planning.

Geologically, the proposed LPG project site lies within the Precambrian Basement Complex formation that underlies much of northern Nigeria. The dominant rock types in the area consist mainly of granites and gneiss, which are typically hard crystalline rocks. Overlying these bedrocks are residual lateritic soils formed through prolonged weathering processes under tropical climatic conditions.

Air quality measurements at the Birnin Kebbi Road site indicate a generally clean environment prior to project activities. Ambient temperature averaged 31.6°C, relative humidity 22%-23%, particulate matter (PM2.5) ranged from 20–27 µg/m³, and PM10 from 26–35 µg/m³, within WHO and FMEnv guidelines. Carbon monoxide was detected in all locations, methane was not detected

in all locations, while formaldehyde, VOCs were present at very low concentrations, posing no immediate health risks. Noise levels were measured at 45.9–53.5 dB, reflecting a moderately quiet environment. These baselines will serve as a reference for monitoring emissions, fugitive gas releases, and occupational safety once the LPG facility becomes operational.

Soil assessments revealed slightly alkaline conditions (pH 7.73–8.88), moderate electrical conductivity (879–1150 µS/cm), and generally good nutrient status. Heavy metals, petroleum hydrocarbons, and BTEX compounds were very low, confirming no prior contamination from hydrocarbon activities. Microbial counts, including E. coli and fungi, were low but detectable, reflecting wet-season runoff and minor human or livestock activity. These conditions indicate that soils are suitable for construction but require standard erosion and runoff control measures during the project lifecycle.

Water quality analysis of nearby groundwater and surface water sources showed largely acceptable physicochemical conditions, with pH of 8.43 and low mineral content. Total suspended solids of 1 mg/L, and phosphate level of 45 mg/L, indicating nutrient input from agricultural runoff. Nitrate concentrations do not exceeded the safe limits (11.4 mg/L), suggesting minor faecal contamination. Chemical Oxygen Demand (COD) was higher than regulatory thresholds in select groundwater samples, highlighting the need for careful monitoring and mitigation during operations. Microbiological tests showed low to moderate E. coli and coliform presence, indicating that water sources are not safe for direct human consumption without treatment.

Vegetation around the Birnin Kebbi Road site is sparse within the immediate project footprint but moderately diverse within a 3 km radius, consistent with Sudan Savannah transition zones. Dominant trees include Baobab (Adansonia digitata), Neem (Azadirachta indica), and scattered Eucalyptus and Acacia species. Herbaceous plants are primarily drought-tolerant species, providing minimal canopy cover but supporting local fauna. Faunal surveys identified small mammals such as grasscutter (Thryonomys swinderianus) and rodents, common savannah birds including Helmeted Guineafowl (Numida meleagris) and Village Weaver (Ploceus cucullatus), reptiles such as Agama lizards, and amphibians in wet microhabitats. No species of conservation concern were observed, though the area is susceptible to anthropogenic pressures such as bush clearing, livestock grazing, and habitat fragmentation.

A comprehensive socioeconomic study was conducted within the area of influence for the proposed LPG depot in Birnin Kebbi Road, Sokoto State, covering five host communities within a 3-kilometer radius of the site. The study employed a stratified random sampling approach to ensure representativeness, with households selected proportionally based on community size and proximity to the project. A total of 92 households were surveyed to capture a balanced demographic and socioeconomic profile of potentially affected populations.

The traditional governance structure in Sokoto State remains anchored in the Hausa Emirate system, where the Sultan acts as the paramount traditional authority. Administrative duties are delegated through District Heads (Hakimi) and Village Heads (Dagachi) at local levels. This system coexists with modern local government administration, with traditional rulers serving as cultural custodians and advisors on social and religious matters. Project engagement requires

consultation and approval from these authorities to ensure acceptance and alignment with local governance practices.

The population in the Birnin Kebbi Road area is predominantly Hausa-speaking and Muslim, with small Fulani and Fufunde minorities. Shared religious practices and social norms guide daily life, including observance of prayer times, gender interactions, and behavioral expectations in communal spaces. Cultural events such as the Sultan of Sokoto's Durbar during Eid highlight the community's deep-rooted traditions. Respecting these values is essential for successful stakeholder engagement and project operations.

Survey results indicate a male-dominated respondent profile (60–71% males), consistent with cultural norms wherein men represent households in public consultations. Islam is overwhelmingly practiced, with minimal Christian presence, and the Hausa ethnic group forms the majority, complemented by smaller Fulani representation. This demographic homogeneity supports coherent community engagement and unified project communication strategies.

Agriculture is the primary livelihood across the surveyed communities, with up to 40% of respondents engaged in farming, particularly in peripheral villages farther from Birnin Kebbi Road. Trading is the second most prevalent occupation, especially in areas closer to the site, reflecting active local markets and entrepreneurial activity. Civil service, artisan crafts, and transportation services feature moderately, while unemployment is relatively low but more notable in peripheral communities (around 10%), indicating seasonal underemployment and limited local opportunities.

Housing stability is generally high, with homeownership rates reaching 80% in some villages. Access to potable water primarily relies on boreholes, with pipe-borne water coverage below 30% in most communities. Electricity access is moderate, with higher availability near Birnin Kebbi Road (approximately 70%), but lower in outlying villages. Access to primary healthcare averages 57%, highlighting gaps in essential services that could be addressed through project-related community support programs. Educational access rates exceed 80% in communities nearest the site, though more distant areas lag behind, reflecting infrastructure and service disparities.

Community perceptions of the LPG depot are generally positive, particularly in Birnin Kebbi Road and neighboring settlements, where over 80% of respondents anticipate benefits such as employment, improved infrastructure, and economic stimulation. Awareness and support taper in more distant communities, with concerns focused on potential environmental impacts, land use, and traffic congestion. These findings emphasize the importance of transparent, inclusive, and ongoing engagement to ensure equitable benefits and minimize opposition.

Residents prioritized improvements in school infrastructure, healthcare services, potable water supply, road networks, electricity access, and employment opportunities. Education and health were highlighted as the most pressing needs, while employment expectations underscore the community's desire for tangible economic benefits from the project. These priorities should guide the LPG depot proponent's corporate social responsibility (CSR) and community investment initiatives, aligning project benefits with local needs.

Traffic assessment along the nearby Sokoto-Zaria Expressway, which serves as a major logistics corridor, revealed high baseline traffic volumes with frequent congestion, accidents, and elevated noise and air pollution near residential settlements. Daily traffic includes heavy-duty trucks, commercial buses, private vehicles, motorcycles, and fuel tankers. The LPG depot's operation is expected to increase daily vehicle movements by approximately 50–85 vehicles, primarily delivery trucks and staff transport. Without mitigation measures such as deceleration lanes, dedicated entry/exit points, and improved signage, this could exacerbate congestion and safety risks.

Security within Birnin Kebbi Road is generally stable, with low crime rates and most residents perceiving their communities as safe. Occasional incidents such as robbery, cattle rustling, and inter-communal disputes were reported, indicating the need for ongoing security vigilance and collaboration with law enforcement agencies. Conflict resolution mechanisms remain robust, with disputes—ranging from land to family disagreements—typically resolved through traditional channels involving village heads and councils of elders. Respect for these indigenous systems is essential for maintaining social cohesion and stability throughout the project lifecycle.

ES 5: Potential and Associated Impacts

The assessment of potential environmental and socioeconomic impacts of the proposed LPG Station in Birnin Kebbi Road utilized a systematic methodology combining checklists, impact matrices, public consultations, and expert judgment. The evaluation process involved three main stages: identifying potential impacts linked to project activities, predicting their nature and magnitude, and evaluating their significance based on receptor sensitivity and impact intensity. Potential impacts were determined by examining interactions between project components and surrounding biophysical and social receptors. Impacts were characterized as beneficial or adverse, direct or indirect, reversible or irreversible, and short- or long-term. Cumulative and residual impacts were also considered to account for combined effects and those persisting after mitigation.

Impact Evaluation Criteria

Impacts were evaluated based on their duration, extent, intensity, and overall severity using a structured impact evaluation matrix, with results categorized as major, moderate, or minor. Environmental and social receptors considered included air quality, noise, soils, water resources, ecology, visual amenities, community health and safety, infrastructure, cultural heritage, employment, and social dynamics.

Project Activities and Phases

The project's activities span pre-construction, construction, operational, and decommissioning phases, each with specific environmental footprints, including land clearing, excavation, construction emissions, waste generation, traffic impacts, and potential hazards such as fire or chemical contamination.

Identified Impacts

During the pre-construction phase, significant adverse impacts are primarily associated with land acquisition, including loss of land and displacement of informal users and subsistence farmers, resulting in livelihood disruptions. These are rated high due to severity, permanence, and social sensitivity. Other negative impacts include potential disputes over compensation, temporary soil compaction, noise, traffic congestion from mobilization activities, and social tensions arising from an influx of job seekers. Site clearing activities pose risks to biodiversity and soil erosion, while unmanaged debris may create visual nuisances of lower severity.

The construction phase is expected to generate major impacts such as soil disturbance and erosion from excavation, construction waste generation, and safety risks associated with heavy equipment installation, including LPG tanks, compressors, and piping. High-rated risks involve accidents during lifting operations, gas exposure, electrocution, and fire hazards. Noise pollution from mechanical works and air emissions from equipment are significant, and risks to worker safety and public health through slips, falls, or exposure to hazards are critical. Waste management and contamination risks are present but generally reversible with proper controls.

During operation, key impacts include air pollution from LPG emissions, noise and vibration from compressors and vehicles, and contamination risks from minor leaks or spills. Fire and explosion hazards are moderate in probability but high in consequence. Additional operational concerns include increased waste generation, pressure on local social amenities, and traffic accidents from tanker deliveries and staff vehicles. While many operational impacts are long-term and potentially irreversible without mitigation, implementation of monitoring and emergency response systems can reduce their significance.

Decommissioning activities generate moderate impacts such as noise, vibration, temporary air quality impairment, and solid waste generation, while loss of employment represents a significant socioeconomic impact. Positive impacts include opportunities for site restoration and re-vegetation. Most decommissioning effects are short-term and reversible with effective planning.

Residual Environmental and Social Impacts

Residual environmental and social impacts in Birnin Kebbi Road indicate that despite mitigation measures, some effects will persist at minimal to moderate levels. Fugitive emissions of LPG could pose localized air pollution and fire risks, while soil and groundwater may be susceptible to minor hydrocarbon leaks, particularly during heavy rainfall. Noise may persist from nighttime operations, and traffic increases on local access roads and the Eastern-Bye Pass Zaria Road highway could exacerbate congestion, accident risk, and road degradation. Occupational health and safety risks remain low probability but require continuous training, personal protective equipment, and safety audits. Socially, if community engagement and CSR programs are not maintained, residual dissatisfaction may arise. Visual aesthetics and land use patterns may be permanently altered, and initial vegetation clearance will cause irreversible loss of flora and minor fauna, partially mitigated through post-decommissioning restoration efforts.

Cumulative Impacts

Cumulative impacts stem from the additive effects of the LPG depot alongside other developments along the Birnin Kebbi Road corridor, including industrial growth, agricultural intensification, traffic increase, and urban expansion. Air quality may degrade due to additional emissions, elevating respiratory risks for nearby populations. Traffic volumes will further strain infrastructure, increasing congestion, accidents, and delays near schools and markets. Water pollution risks from small leaks or storm-water runoff may compound existing contamination from other facilities, potentially affecting aquifers and agriculture. Noise and vibration from project operations and increased traffic may contribute to stress, sleep disturbances, and minor wildlife disruption. Ecologically, habitat fragmentation and vegetation loss may reduce ecosystem services such as flood regulation and pollination. Socially and economically, benefits from jobs and energy access may be offset by inequitable distribution, particularly among women and youth, generating potential grievances. Finally, although LPG is a cleaner fuel, the depot incrementally contributes to regional greenhouse gas emissions, adding to broader climate change concerns.

ES 6: Mitigation Measures

The mitigation measures for the proposed LPG Station project in Birnin Kebbi Road are designed to manage potential adverse impacts within acceptable limits by focusing on avoidance, reduction, and control of impacts across all project phases. These measures are categorized into preventive actions during design and pre-construction to avoid or minimize major impacts at their source, control measures during construction and operation to abate unavoidable effects, and compensatory measures for impacts that cannot be fully mitigated.

Pre-Construction Phase Mitigation

During the pre-construction phase, mitigation involves fair land acquisition processes, including compensation and livelihood restoration plans, engagement with traditional leaders and stakeholders to minimize conflicts, and inclusive community sensitization to prevent exclusion of vulnerable groups. Soil and site surveys employ low-impact techniques to minimize vegetation disturbance, while equipment mobilization follows traffic management plans and noise controls. To address potential social tensions from an influx of job seekers, recruitment prioritizes host community members, and transparent grievance redress mechanisms are established. Site clearing activities incorporate strict limits and erosion control measures, while initial waste generation is managed through proper segregation and daily site cleanups.

Construction Phase Mitigation

During construction, erosion control is implemented using silt fences and proper scheduling, while construction waste is segregated and disposed of by licensed vendors. Occupational safety protocols are enforced during heavy lifting, welding, and equipment operation, and noise is reduced through dampeners and restricted working hours. Fire safety is ensured via hot work permits and trained fire watchers, while electrical safety follows certified installation standards. Hydro-testing uses biodegradable chemicals with treated discharge, and generator operations

include regular servicing and noise suppression. Daily safety briefings and adequate first aid provisions mitigate risks to workers and the public.

Operational Phase Mitigation

During operation, delivery scheduling and traffic signage control congestion and reduce accident risks. Gas handling is safeguarded with emergency shutdown valves, gas detectors, and comprehensive operator training to prevent leaks and explosions. Equipment noise and emissions are controlled through enclosures, maintenance, and low-emission generators. Safety measures include calibration and monitoring of gas meters, use of auto-stop nozzles during cylinder filling, and strict PPE enforcement during maintenance. Waste handling involves sealed containment and licensed disposal, while ongoing community engagement and grievance mechanisms maintain positive social relations. Public safety education supports safe gas distribution and sales.

Decommissioning Phase Mitigation

In the decommissioning phase, a clear plan communicated early to stakeholders mitigates community unrest. Equipment dismantling is conducted by trained crews using PPE and permit systems to prevent injuries. Hazardous waste is segregated and disposed of by accredited vendors under environmental audits. Soil restoration involves re-grading, loosening compacted areas, and native species. Staff disengagement is managed with severance packages and re-employment support to reduce social dissatisfaction. Infrastructure removal is coordinated with utility companies to prevent damage, and a final audit ensures compliance with closure obligations.

ES 7: Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) for the LPG Depot project in Birnin Kebbi Road aims to ensure all activities comply with relevant environmental laws and policies, minimize adverse biophysical, health, and social impacts, and promote continuous improvement in environmental performance. It ensures full implementation of mitigation measures, prepares for emergency response, facilitates planning, monitoring, and auditing, and fosters early stakeholder consultations for smooth operations. The EMP covers identifying roles, setting measurable targets, communication procedures, risk mitigation, and capacity building.

Roles and Responsibilities

Implementation involves multiple stakeholders with distinct roles. The project proponent, ZAGR, must be well-versed in the EMP, communicate progress, review and approve operational methods, coordinate with regulators, manage grievances, allocate resources, enforce compliance among contractors, and maintain proactive stakeholder communication. Regulators such as FMEnv and DPR are responsible for enforcing guidelines, ensuring compliance throughout the project lifecycle, providing stakeholder training on environmental management, and designating protected environmental areas.

Management Commitment

ZAGR's commitment is articulated through its Health, Safety, and Environmental (HSE) policy, emphasizing protection of employees, contractors, the public, and the environment while being sensitive to community needs. HSE principles are integrated into all operations, ensuring compliance with laws and standards, promoting continuous improvement, maintaining emergency preparedness, and holding contractors accountable for adherence. ZAGR pledges socially responsible leadership, transparency through reporting, risk assessments, and stakeholder engagement, while adopting best practices in design, operations, and regulatory collaboration.

Flora and Fauna Management Plan

The plan protects local biodiversity and safeguards personnel, prohibiting handling or harming wildlife and plants and forbidding poaching by employees or contractors. Land clearing is minimized and carefully managed, with notifications to the Ministry of Environment's Wildlife Division if vulnerable species are affected. Aquatic habitats are monitored, the site is kept clean to avoid attracting animals, invasive species are managed, and community awareness campaigns reduce bush meat demand. Collaboration with conservation groups helps prevent poaching.

Waste Management Plan

This plan minimizes waste generation and ensures proper handling, reuse, recycling, treatment, or safe disposal to prevent environmental harm. Responsibilities include appointing a trained Waste Management Supervisor, cataloging waste types and quantities, providing labeled bins for segregation, and managing hazardous waste according to safety data sheets. Accredited contractors handle hazardous and recyclable waste, tracked using a waste manifest system. Periodic inspections and reconciliation of waste records ensure compliance.

Erosion and Sedimentation Management Plan

Guidelines control soil erosion and sediment transport to waterways, protecting fertile topsoil and water quality. Vegetated buffer zones along streams are preserved, leguminous cover crops are used, and site clearing is phased to prevent sediment discharge. Temporary erosion control devices are installed during earthworks, and permanent measures like terracing and re-vegetation are established. Stormwater is managed through designated flow paths, erosion protection structures, and drainage systems, while soil piles are secured, and natural drainage features are maintained.

Employment, Training, and Awareness Management Plan

Implemented during construction and operations, this plan ensures workers receive health and safety training through orientations and weekly safety sessions. Modules cover induction, community relations, first aid, handling venomous animals, PPE usage, and safe work procedures, with all activities documented.

Water Management Plan

This plan conserves and protects water resources by training workers, controlling sedimentation and erosion, managing waste to prevent contamination, monitoring effluent quality, and ensuring

water withdrawals do not harm aquatic environments or other users. Standards for well installation prevent adverse groundwater impacts.

Vegetation Clearing and Biomass Management Plan

Responsible clearing practices minimize habitat and biodiversity damage. Cleared and protected areas are delineated, fauna are allowed to relocate, timber is used sustainably, non-timber forest products are made available for community use, and biomass waste is properly managed. This plan complements other management strategies to protect workers, the environment, and communities.

Air Quality Management Plan

The plan ensures adherence to Nigerian noise regulations, use of modern low-emission tanks and vehicles with pollution controls, and prohibition of ozone-depleting substances.

Emergency Response and Incident Management Plan

Procedures cover fires, floods, hazardous spills, medical emergencies, and other incidents, assigning responsibilities, outlining spill response protocols, providing training, and ensuring coordination with rescue services and authorities to protect people and the environment.

Traffic and Vehicle Management Plan

Speed limits and signage are enforced, drivers receive specialist safety training, and regular vehicle maintenance and inspections minimize emissions, noise, and accident risks.

Health, Safety, and Security Management Plan

The plan aligns with ZAGR and international best practices, covering PPE provision and use, risk analyses, equipment safety training, physical access control, job-specific hazard training, and first aid readiness including ambulance availability.

Community Health and Safety Plan

Risks from increased population and economic activity during construction, such as crime and disease, are addressed. The plan promotes local hiring to reduce migrant influx, enforces worker codes of conduct, educates communities on risks, and collaborates with health authorities for monitoring and awareness.

Stakeholders Engagement Plan

Stakeholders are identified, past consultations documented, youth and women engaged, and ongoing dialogue maintained. Resource allocation and grievance management ensure accessible, confidential, and timely handling of complaints without cost or retribution.

Decommissioning Plan

Closure activities include employee retrenchment support, infrastructure repurposing, staff capacity building, and site restoration to native vegetation or agricultural use, updated as closure approaches.

Phase-Specific EMP Measures

Pre-construction mitigation addresses displacement, biodiversity loss, traffic safety, noise, and social tensions through compensation, livelihood restoration, community engagement, controlled site clearing with revegetation, traffic management, and local hiring. Monitoring tracks grievances, site disturbance, traffic incidents, and complaints. Construction measures manage soil erosion, noise, fire, hydrotest chemicals, generator emissions, and waste, enforced via PPE, safety briefings, and monitoring of sediment, noise, permits, emissions, waste, and incidents. Operational measures focus on fire/explosion risks, noise reduction, emissions control, safe cylinder filling, waste handling, and community relations, monitored via gas detectors, noise, air quality, waste inspection, and feedback. Decommissioning measures prevent unrest and environmental harm through early communication, safe equipment dismantling, hazardous waste segregation, soil restoration, worker support, and monitoring compliance, waste disposal, site restoration, and grievances.

Environmental Audit Programme

Regular audits ensure compliance with regulations, identify potential environmental issues, verify mitigation implementation, and recommend improvements.

Environmental Monitoring Programme

Impact and compliance monitoring includes air quality (PM_{10}, $PM_{2.5}$, CO, NO_x, SO_2, H_2S), noise levels (day/night dB(A)), groundwater and surface water quality (pH, heavy metals, hydrocarbons, BOD, COD, oil & grease), soil quality, vegetation and biodiversity status, socioeconomic indicators (grievances, employment, CSR), occupational health and safety metrics (PPE use, incidents), greenhouse gas emissions (CO_2 equivalents), and waste management practices. Sampling occurs at tanker bays, generator areas, site perimeters, nearby water bodies, boreholes, and host communities, with monitoring frequency from monthly to bi-annual. Responsible parties include ZAGR, contractors, consultants, FMEnv, and regulatory bodies, with estimated costs budgeted monthly and quarterly.

ES 8: Decommissioning and Abandonment Plans

Projects like the proposed LPG station in Birnin Kebbi Road typically have a defined lifespan, after which they are decommissioned and abandoned. The lifespan depends on factors such as equipment availability, durability, profitability, and the usefulness of the end product. Petroleum facilities generally have a design life of about 30 years. Eventually, due to outdated technology or

economic non-viability, the facility will need to be safely and environmentally decommissioned by ZAGR.

The decommissioning plan involves dismantling the site, remediating the soil, and properly disposing of waste, including excavated soil and debris, either through backfilling or approved dumping sites. Workers will receive capacity building to raise awareness of risks and safety measures during decommissioning. ZAGR, in consultation with regulatory bodies such as FMEnv, DPR, and SASEPA, as well as host communities, will restore the site to its original state.

The decommissioning process will include removal and draining of tanks and vessels, dismantling buildings and structures, recycling usable components, disconnecting utilities, and re-vegetating disturbed areas with native species. Environmental restoration will also address any contamination caused by the project, ensuring that soil, water, and vegetation are returned to conditions suitable for agricultural or ecological use, where feasible.

ES 9: Conclusion

This Environmental Impact Assessment (EIA) for the ZAGR LPG Depot project in Birnin Kebbi Road was conducted following Nigerian Environmental Impact Assessment laws and regulations. The EIA process included screening, scoping, baseline data collection, stakeholder consultation, impact assessment, management planning, and reporting. Public participation was undertaken to inform stakeholders and gather input on the project and its potential effects, ensuring that local concerns and suggestions were considered. Baseline data on environmental and socio-economic conditions were collected to accurately assess potential project impacts.

The EIA identified both positive and negative impacts, with mitigation measures designed to minimize adverse effects and enhance benefits. Key adverse impacts include air pollution, contamination of soil and water from effluents, workplace accidents, and improper waste management. Mitigation measures aim to reduce these impacts to acceptable levels, ensuring biodiversity conservation and compliance with Nigerian environmental standards. Monitoring will ensure ongoing adherence to these measures and support continuous improvement.

The significance of most negative impacts, such as biodiversity loss, resettlement effects, and air quality degradation, can be reduced to moderate or minor levels with mitigation. Noise impacts were assessed as negligible prior to mitigation. Greenhouse gas emissions during operation remain significant due to limited mitigation options, while soil impacts during construction are moderate but manageable. Positive impacts include substantial contributions to the national economy and local employment, which are expected to remain highly significant even after mitigation measures are implemented.

ACKNOWLEDGEMENT

The Proponent of the proposed Liquefied Petroleum Gas (LPG) Refilling Plant in Bodinga Local Government Area of Sokoto State expresses its sincere appreciation to the relevant regulatory authorities and government institutions, particularly the Federal Ministry of Environment, whose guidance, oversight, and professional input greatly facilitated the successful completion of this Environmental and Social Impact Assessment (ESIA).

The Company also acknowledges with gratitude the contributions of the appointed consultants, Godai Calibration & Multi Resources Limited, the technical team members, and representatives of the host community for their active participation, cooperation, and valuable insights throughout the study period. Their collective efforts and constructive engagement were instrumental in ensuring the quality, credibility, and successful delivery of this report.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Zamson Global Resources Limited (ZAGR), an indigenous energy company committed to promoting clean and efficient energy solutions in Nigeria, proposes to establish a modern modular Liquefied Petroleum Gas (LPG) storage and refilling plant with a bulk storage capacity of two hundred (200) metric tons. The proposed facility will be located opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State. The project is designed to enhance the availability, accessibility, and affordability of LPG for domestic, commercial, and industrial consumers within Sokoto metropolis and its surrounding communities.

The proposed facility will operate as a bulk LPG storage and cylinder refilling plant, equipped with eight (08) electronically controlled refilling machines. These units will be configured to dispense LPG into 6 kg, 12 kg, 25 kg, and 35 kg cylinders primarily for household use, while also accommodating larger cylinder sizes for industrial and commercial applications. The bulk storage tank will contain LPG, a pressurized mixture of propane and butane, which are liquefied hydrocarbon products obtained from natural gas processing and associated petroleum operations.

Natural gas is a naturally occurring mixture of hydrocarbon gases found beneath the earth's surface, often in association with crude oil deposits. It consists predominantly of methane, along with varying proportions of ethane, propane, butane, and nitrogen. In essence, it is a combustible mixture of hydrocarbon gases trapped within the pore spaces of sedimentary rock formations. Before utilization as a fuel, natural gas undergoes processing to remove impurities and separate valuable components. These processes yield by-products such as ethane, propane, butane, pentane, and other higher molecular weight hydrocarbons, as well as impurities including sulphur, helium, and nitrogen.

Propane, a three-carbon alkane with the molecular formula C_3H_8, exists in gaseous form under standard conditions but can be compressed into a liquid for ease of storage and transportation. It is a major component of LPG and is widely used as a clean-burning fuel for domestic cooking, heating, industrial processes, internal combustion engines, and oxy-gas cutting operations. When combined with butane and stored under moderate pressure, propane forms LPG, which is recognized for its efficiency, portability, and relatively low emission profile compared to traditional biomass fuels and other fossil fuels.

The establishment of the 200 metric tons LPG storage and refilling plant in Bodinga Local Government Area aligns with Nigeria's policy on domestic gas utilization and the transition toward cleaner energy sources. The project is expected to improve access to reliable cooking energy, stimulate local economic development, reduce dependence on firewood and charcoal, and contribute to environmental sustainability through reduced greenhouse gas emissions and improved air quality within Sokoto State.

In line with the Company's commitment to environmental responsibility and regulatory compliance, the proposed project will be subjected to a comprehensive Environmental Impact Assessment (EIA) in accordance with the Environmental Impact Assessment Act, Cap E12, Laws of the Federation of Nigeria (LFN) 2004. The assessment will identify and evaluate potential environmental and social impacts associated with the project and propose appropriate mitigation measures. Furthermore, the project will strictly comply with the safety requirements and operational guidelines of the National Midstream and Downstream Petroleum Regulatory Authority and the Federal Ministry of Environment, as well as internationally recognized best practices, including standards of the National Fire Protection Association for LPG facilities.

This document therefore presents the project justification, outlines its scope and key components, and highlights the environmental management strategies designed to ensure sustainability and effective integration with the host community throughout the project lifecycle.

1.2 GEOGRAPHICAL DESCRIPTION OF THE PROJECT LOCATION

The project site is located OPPOSITE AIRPORT, BIRNIN KEBBI ROAD, BODINGA LGA, SOKOTO STATE. The land under application is flat bounded with vacant land by the left, right and rear sides. The project site location lies between latitude of 12° 55' 54.1" N and longitude of 5° 11' 18.9'' E with an elevation of 304 m above the sea level. The size of the land is 100m by 110m square

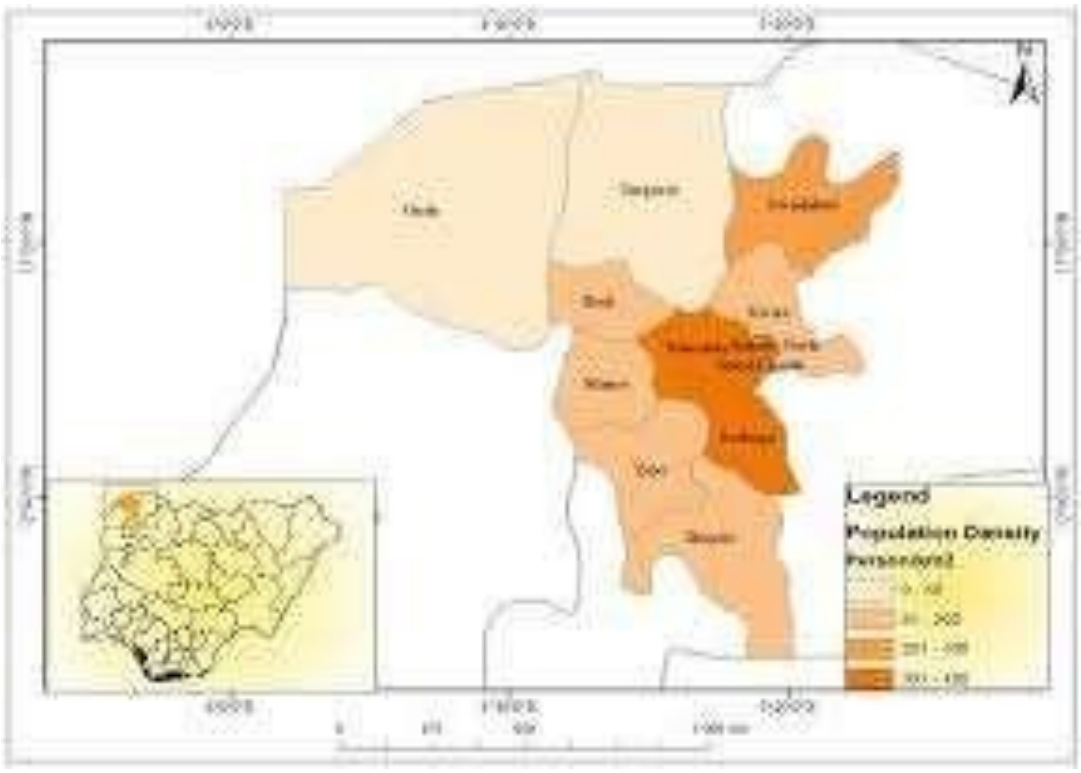


Figure 1.1: Map of the Sokoto State Showing Bodinga the LGA of the Project

Figure 1.2: Google Map showing the project Location

1.3 THE PROJECT PROPONENT

Zamson Global Resources Limited (ZAGR) is a duly registered Nigerian company operating within the midstream and downstream sectors of the oil and gas industry. The Company is dedicated to the development of modern gas infrastructure aimed at enhancing domestic energy supply, improving distribution efficiency, and promoting the adoption of cleaner energy alternatives across the country. Its corporate vision is anchored on delivering safe, efficient, and environmentally sustainable energy solutions that support national development and long-term economic growth.

In the execution of its operations, Zamson Global Resources Limited maintains strict adherence to relevant regulatory requirements and industry best practices. The Company is committed to full compliance with environmental, health, and safety standards as prescribed by applicable federal and state authorities. It integrates key principles such as risk assessment, pollution control, and stakeholder engagement into all stages of project planning, development, and operation.

As the proponent of the proposed 200 metric tons LPG storage and refilling plant to be located opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State, Zamson Global Resources Limited aims to improve access to affordable, reliable, and cleaner energy for both domestic and industrial users within Sokoto metropolis and surrounding communities. The project is designed to encourage increased utilization of Liquefied Petroleum Gas (LPG) as a safer and more environmentally friendly alternative to traditional biomass fuels and other high-emission energy sources, thereby contributing to improved public health, reduced environmental degradation, and enhanced air quality

1.4 THE EIA OBJECTIVES

The primary objective of conducting an Environmental Impact Assessment (EIA) in Nigeria is to ensure that development projects are implemented in an environmentally sustainable and socially responsible manner, consistent with national regulations and internationally accepted best practices.

For the proposed LPG Storage and Refilling Plant by Zamson Global Resources Limited in Bodinga LGA, Sokoto State, the specific objectives of the EIA are to:

- Identify and predict the potential environmental and social impacts of the proposed project prior to implementation.
- Propose practical measures to avoid, minimize, mitigate, or compensate for adverse impacts while enhancing positive benefits.

- Safeguard the integrity, productivity, and ecological functions of natural resources such as land, water, and air within the project area.
- Conduct baseline environmental studies, including sampling and analysis of soil, water, and ambient air quality using recognized scientific methods.
- Ensure that environmental considerations are fully integrated into project planning, design, construction, and operational decision-making processes.
- Facilitate stakeholder engagement and public consultation to promote awareness and incorporate community concerns into project development.
- Promote compliance with relevant environmental laws, policies, standards, and regulatory requirements.
- Evaluate safety performance, identify potential risks, and recommend appropriate control and management measures.
- Provide relevant environmental information to regulatory authorities to support informed decision-making prior to project approval and licensing.
- Encourage sustainable development by balancing economic growth with environmental protection and social well-being.

1.5 TERMS OF REFERENCE

A Terms of Reference (ToR) was prepared for the proposed project to ensure a comprehensive assessment of the environmental setting of the project area. The ToR outlines the scope of investigations to be carried out during the EIA study, with emphasis on the following activities:

- Conducting a one-season field survey within the project area to validate and complement existing environmental data and information.
- Reviewing applicable national and international environmental regulations and guidelines relevant to erosion control, land reclamation, and site stabilization.
- Undertaking an extensive literature review to establish the baseline biophysical and socio-economic conditions of the project area.
- Performing laboratory analysis of environmental samples obtained during the field survey and sampling programme.
- Identifying, predicting, analysing, and evaluating potential environmental, socio-economic, and public health impacts associated with the proposed project.
- Formulating appropriate avoidance and mitigation measures, as well as a monitoring programme, for inclusion in an Environmental Management Plan (EMP).

- Preparing both draft and final Environmental Impact Assessment (EIA) reports in accordance with the standards and guidelines of the Federal Ministry of Environment (FMEnv).

The one-season baseline data collection exercise approved by FMEnv will cover key biophysical, socio-economic, and public health components of the project area, as summarized below:

Biophysical

- Climate/Meteorology
- Surface Water
- Soil
- Land use
- Ambient air quality
- Noise and Vibration
- Vegetation
- Terrestrial and aquatic wildlife
- Geology

Social

- Demographic attributes of the surveyed communities
- Socio-cultural issues
- Infrastructural facilities
- Structure of the local economy
- Social conditions of communities
- Archaeological and historical data

Health

- Health status of the studied communities
- Existing health facilities
- Health statistics and disease pattern
- Existing health hazards
- Perceived potential health hazards

1.6 METHODOLOGY FOR THE EIA

The EIA study followed a systematic process that included preliminary planning and review, field data collection, data analysis and interpretation, report preparation, and expert and stakeholder review. The overall procedure adopted for the study is consistent with the Environmental Impact Assessment management framework of the Federal Ministry of Environment (FMEnv), as illustrated in Figure 1.4 below.

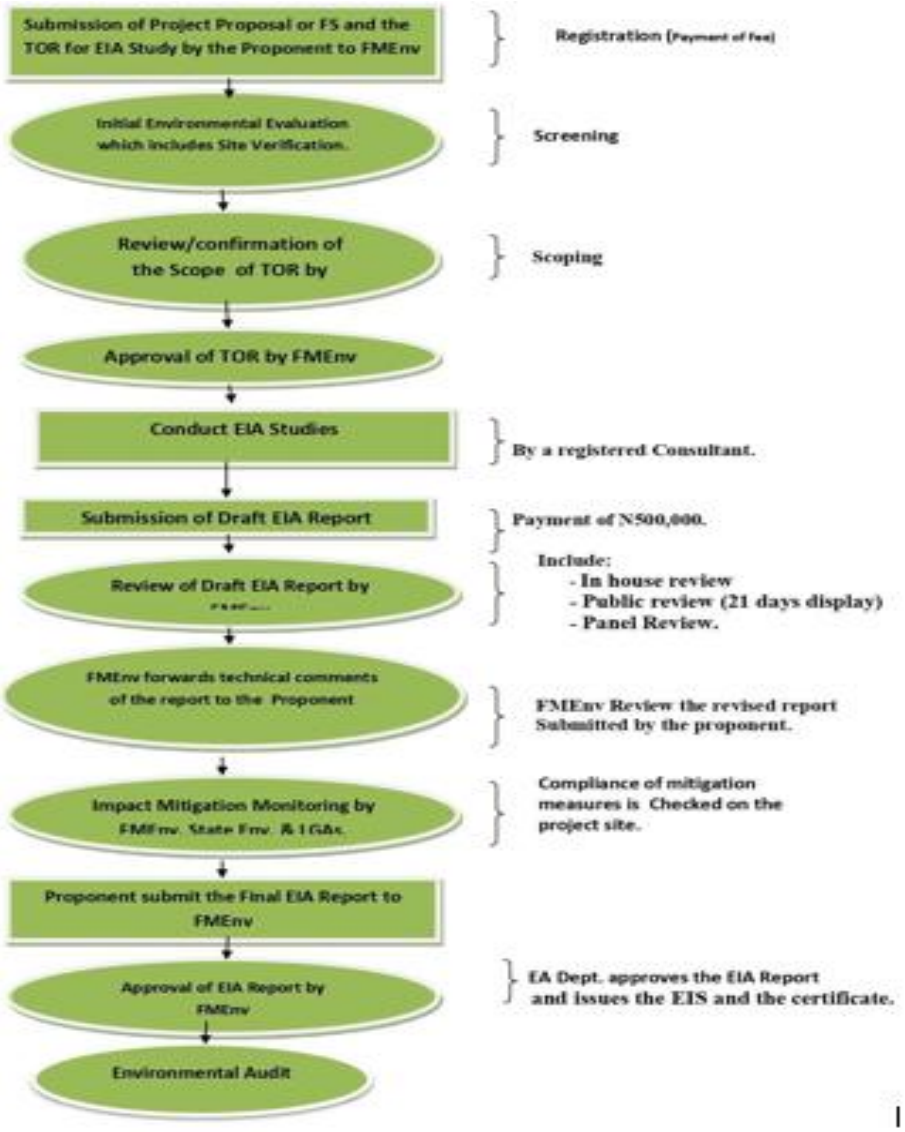


Figure 1.3. FMEnv EIA Management Procedure

1.6.1 Site Identification

For the proposed 200 metric tons Liquefied Petroleum Gas (LPG) Storage and Refilling Plant to be sited opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area, the Environmental Impact Assessment (EIA) study incorporated detailed, site-specific data to ensure a comprehensive and accurate characterization of the project environment. Relevant project information was systematically gathered and documented, including the facility layout plan, precise Global Positioning System (GPS) coordinates of the site, photographic records of existing site conditions, and other technical data required for effective site description and environmental analysis.

Furthermore, Geographic Information System (GIS) applications and remote sensing techniques were utilized to assess the spatial characteristics of the project area and its immediate surroundings. These

tools enabled the identification and mapping of existing land use patterns along Birnin Kebbi Road, nearby settlements, transport infrastructure, and sensitive receptors within the vicinity of the proposed site. Particular attention was given to the proximity of the Airport and associated activities in order to ensure that all potential environmental and safety considerations were adequately captured. This approach significantly enhanced the accuracy, reliability, and overall robustness of the environmental assessment for the proposed LPG facility

1.6.2 Fieldwork Activities and Site Inspection

A comprehensive field reconnaissance and environmental data collection exercise was conducted for the proposed 200 metric tons Liquefied Petroleum Gas (LPG) Storage and Refilling Plant opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State. The exercise aimed to establish baseline environmental conditions of the project site and its immediate surroundings.

The field survey was carried out by a multidisciplinary team of experts in environmental management, geology, chemistry, biology, socio-economics, urban and regional planning, and geography. Key activities undertaken included on-site observations, environmental screening, in-situ measurements, stakeholder consultations, and the collection of soil, water, and ambient air samples for subsequent laboratory analysis.

The investigation was conducted in strict accordance with the Environmental Impact Assessment guidelines of the Federal Ministry of Environment and other regulatory standards applicable to LPG facilities. Site verification and environmental sampling were performed on 30th December 2025. The purpose of the exercise was to gain a clear understanding of the physical environment, ecological characteristics, land use patterns, and socio-economic conditions of the host community. Data and insights obtained during the reconnaissance informed the design of the study, the sampling strategy, and the overall environmental assessment framework for the proposed LPG facility.

1.6.3 Literature Review

The desktop component of the EIA study was based on reliable field and laboratory data obtained from recently completed Environmental Impact Assessments within Sokoto State. In particular, reference was made to the Environmental Impact Assessment the Proposed Borkir LPG Terminal Onne Freezone Ports, Eleme LGA, River State, Nigeria undertaken by Bokkir International Company LTD in October 2024.

1.7 Administrative and Legal Framework

This section presents a review of the applicable statutory and regulatory requirements relevant to the proposed LPG refilling Plant in Bodinga Local Government Area, Sokoto State.

1.7.1 National Regulations and Framework Constitution of the Federal Republic of Nigeria (1999)

The 1999 constitution makes the protection on the Nigerian environment mandatory in the following relevant sections:

- **Section 20** makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria;
- **Section 33 of** the 1999 constitution guarantee fundamental human rights to life while **Section 34** guarantees rights to human dignity of which a healthy and safe environment is part of these rights.
- **Section 12** establishes that international treaties ratified by the National Assembly should be implemented as law in Nigeria. This implies that an international treaty on the environment that has been ratified by the National Assembly is effective as legislations of the Federal Republic of Nigeria. Some of these treaties relevant to the proposed project include:
    - ✓ International Union for Conservation of Nature and Natural Resources (IUCN)Guidelines (1996)
    - ✓ Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)
    - ✓ Convention on Biological Diversity (1992)
    - ✓ Convention Concerning the Protection of the World Cultural and Natural Heritage Sites (or World Heritage Convention, 1978)
    - ✓ Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (1987)
    - ✓ United Nations Framework Convention on Climatic Change (1992)

The Nigerian Urban and Regional Planning Act CAP N.138, LFN 2004

The Urban and Regional Planning Act is aimed at overseeing a realistic and purposeful planning of the country to avoid overcrowding and poor environmental conditions. In relevant sections of the Act pertinent to the proposed project are:

- **Section 30 subsection 3** which require a building plan to be drawn by a registered architect or town planner;
- **Section 39 subsection 7** provides that an application for land development would be rejected if such development would harm the environment or constitute nuisance to the community;
- **Section 59** makes it an offence to disobey stop-work order;
- **Section 72** provides for the preservation and planting of trees for environmental conservation.

Federal Environmental Protection Agency FEPA (Now Federal Ministry of Environment (FMEnv)) Act No. 58, 1988

The Federal Environmental Protection Agency Act, CAP 131, LFN was passed in 1988 and subsequently amended by Act No. 59 of 1992. All matters relating to environment of Nigeria are under the jurisdiction of the Federal Ministry of Environment (FMEnv), which was established in 1999. Before then matters of environmental protection and conservation was the responsibility of the Federal Environmental Protection Authority (FEPA). The main function of the Ministry is to provide the appropriate legal and institutional framework for the management of the Nigerian environment.

Relevant to the proposed project is Section 4(a) which states that "The Agency shall, subject to this Act, have the responsibility for the protection and development of the environment and biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology, including initiation of policy in relation to environmental research and technology, and without prejudice to the generality of the foregoing, it shall be the duty of the Agency to "prepare a comprehensive national policy for the protection of the environment and conservation of natural resources, including procedure for environmental impact assessment for all development projects".

Environmental Impact Assessment Act CAP E12 LFN 2004

The Environmental Impact Assessment (EIA) Act No. 86 of 1992 was one of the primary laws enacted to provide a statutory framework for environmental protection and action. The EIA Act makes EIA mandatory for all new major public and private projects in Nigeria. It sets out to:

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

The Act gave specific powers to the then Federal Environmental Protection Agency (FEPA), now Federal Ministry of Environment (FMEnv) to facilitate environmental assessment of projects.

Nigerian National Petroleum Corporation Act, Cap. N123 LFN 2004

The Nigerian National Petroleum Corporation (NNPC) Act, Cap. N123 LFN 2004, though now largely superseded by the Petroleum Industry Act (PIA) 2021, still provides relevant historical and institutional context for understanding Nigeria's oil and gas sector governance. As it relates to the

proposed project on LPG, the NNPC Act outlines several foundational principles that indirectly support and influence such projects.

Under the Act, the Nigerian National Petroleum Corporation (NNPC) was mandated to oversee the development and regulation of Nigeria's petroleum industry, including the midstream and downstream sectors that encompass gas storage, processing, and distribution. Specifically, the Act empowered the Corporation to engage in activities that promote the refining, transportation, marketing, and distribution of petroleum products, including LPG, either directly or through its subsidiaries and partnerships.

The LPG depot project aligns with the objectives of the NNPC Act in the following ways:

Promotion of Gas Utilization and Infrastructure: One of the NNPC's key mandates under the Act was to promote the efficient use of Nigeria's abundant natural gas resources. The development of a depot for LPG supports the federal government's gas expansion program, aimed at reducing reliance on diesel and petrol, improving energy access, and mitigating environmental pollution. Though the NNPC Act does not explicitly mention LPG, these products fall within the broader category of petroleum products managed under its regulatory scope.

Support for Downstream Development: The Act allowed the NNPC to establish or partner with other entities for the construction and operation of downstream infrastructure, such as depots, pipelines, and retail facilities. The project fits into this category, as it seeks to enhance the distribution of cleaner fuel options, especially in northern Nigeria where such infrastructure is still emerging.

Institutional Coordination: Although NNPC itself is no longer the sole commercial operator or regulator following the PIA, the institutional structures and experience it built under the NNPC Act remain relevant. For instance, collaboration with NNPC Retail, NIPCO, or other former subsidiaries could facilitate bulk supply or technical expertise for the proposed depot.

Regulatory Linkage and Legacy Framework: The project must comply with regulatory guidelines that were initially developed under the NNPC's coordination, including environmental standards, safety protocols, and design criteria for gas facilities. These guidelines have been adopted and updated under the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA), which now oversees such infrastructure but builds upon the regulatory precedents established by the NNPC and

the Act.

Petroleum Industry Act 2021

The Petroleum Industry Act (PIA) 2021 is a comprehensive reform legislation that ZAGR aced the Nigerian National Petroleum Corporation (NNPC) Act, Cap. N123 LFN 2004, and made substantial changes to the legal and institutional framework governing the petroleum sector in Nigeria. The PIA aims to enhance the governance, accountability, and efficiency of the oil and gas industry, which includes both upstream and downstream operations.

In relation to the Liquefied Petroleum Gas (LPG) depot project, the PIA provides a clear and updated regulatory framework that directly impacts the development, operation, and monitoring of such projects. Below is an overview of how the PIA is relevant to the project:

1. Midstream and Downstream Sector Regulation

Under the PIA, the midstream and downstream sectors — which include transportation, storage, distribution, and marketing of petroleum products such as LPG and LPG — have been restructured. Specifically, the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) has been established to regulate these sectors. The authority is tasked with ensuring:

Safety: Establishing safety standards for the construction and operation of LPG depots.

Licensing and Permitting: Granting the necessary licenses for the operation of gas facilities like the Birnin Kebbi Road plant.

Environmental Compliance: Enforcing environmental standards related to gas storage and distribution, ensuring the project complies with national and international standards for emissions, waste management, and resource utilization.

This means that the LPG depot will need to align with the requirements set forth by the NMDPRA in terms of obtaining operating permits, environmental approvals, and safety certifications.

2. Gas Flare Commercialization and Utilization

The PIA encourages the utilization of natural gas resources for economic purposes, including LPG.

Under the Act, efforts to reduce gas flaring and promote gas utilization are key national goals. The establishment of a storage and dispensing depot for LPG at Birnin Kebbi Road supports the national objectives outlined in the PIA to use natural gas as a cleaner and more efficient alternative fuel.

The PIA also provides for the commercialization of gas and incentivizes private sector involvement in gas infrastructure development, such as the Birnin Kebbi Road depot, to contribute to the national gas agenda. This means the project can benefit from the broader policy of encouraging gas-based energy infrastructure.

3. Institutional Roles and Governance

The PIA introduced significant changes in the governance structure of Nigeria's oil and gas sector. The Nigerian Petroleum Regulatory Commission (NPRC) was established under the PIA to oversee the upstream sector, while the NMDPRA is now responsible for the midstream and downstream sectors. These institutions will ensure that the LPG depot complies with modern regulations in areas such as environmental sustainability, safety standards, and operational licensing.

The PIA also emphasizes corporate governance, accountability, and transparency in the operations of gas facilities, which will be critical for the long-term sustainability of the project.

4. Local Content Development

A key feature of the PIA is its strong emphasis on local content and the empowerment of local businesses and communities in the oil and gas sector. The Local Content Development Act within the PIA mandates the use of local resources, personnel, and expertise in gas infrastructure projects, including LPG facilities. The project will need to comply with these provisions, ensuring that local businesses and skilled workers are engaged in the construction, operation, and maintenance of the depot.

5. Environmental Protection and Sustainability

The PIA incorporates stringent environmental protections for projects in the petroleum sector, including gas storage and dispensing facilities. It requires that operators of midstream and downstream facilities, like the Birnin Kebbi Road depot, adhere to best practices in environmental management. The project will be subject to comprehensive Environmental Impact Assessments (EIA)

to ensure that potential negative impacts are identified and mitigated.

Additionally, the PIA empowers the NMDPRA to enforce compliance with environmental laws, including the management of gas emissions, water and air quality, and the handling of hazardous materials. This ensures that the Birnin Kebbi Road plant aligns with environmental sustainability goals, preventing harmful emissions, such as methane, from entering the atmosphere.

6. Revenue Generation and Gas Pricing

The PIA introduces a framework for pricing and revenue collection from natural gas. The regulatory authority, under the PIA, oversees the pricing mechanism for LPG, ensuring that these products are priced fairly, transparently, and in alignment with market conditions. For the Birnin Kebbi Road project, this means that the sale and distribution of LPG will be governed by a regulated pricing structure set by the NMDPRA.

Additionally, the PIA seeks to boost investment in the energy sector, and projects like Birnin Kebbi Road may be eligible for incentives that facilitate the growth of the gas sector, including tax reliefs or grants aimed at improving infrastructure and operations.

National Environmental Standards and Regulations Enforcement Agency (NESREA) Act 25 of 2007

The National Environmental Standards and Regulations Enforcement Agency (NESREA) Act, 2007 (Act No. 25) established NESREA as the primary agency responsible for enforcing all environmental laws, guidelines, policies, and standards in Nigeria, excluding those in the oil and gas sector which are regulated by the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) under the Petroleum Industry Act. However, where gas infrastructure projects, like the Birnin Kebbi Road depot, intersect with broader environmental concerns—such as biodiversity conservation, air quality, waste management, and public health—NESREA's mandates remain relevant. The project must therefore align with national environmental regulations to prevent and mitigate pollution, protect ecosystem services, and ensure the well-being of surrounding communities. NESREA's regulations on air emissions, noise pollution, hazardous waste handling, and environmental compliance monitoring serve as a compliance baseline, especially where jurisdiction overlaps or where non-petroleum-related impacts arise.

Nigeria's National Agenda 21 (1992)

The Nigeria National Agenda 21 (1992), developed as a response to the global Agenda 21 from the

Rio Earth Summit, outlines Nigeria's commitment to sustainable development across sectors, including energy, industry, and the environment. It emphasizes integrating environmental considerations into planning and decision-making at all levels. The Birnin Kebbi Road LPG project aligns with the energy and sustainable development objectives of Nigeria's Agenda 21 by promoting access to cleaner energy alternatives (LPG), reducing dependence on conventional fossil fuels, and improving environmental quality. The project supports the national shift towards low-carbon energy options and aligns with the Agenda 21 pillars of energy efficiency, poverty reduction, environmental sustainability, and public participation in environmental governance. Furthermore, Agenda 21 promotes stakeholder engagement and environmental education, which are integral to the EIA process for the project.

Forestry Law, CAP F1, LFN 2004

The Forestry Law, Cap F1, LFN 2004, provides for the protection and management of forest resources in Nigeria. While the proposed site at Birnin Kebbi Road is not within a designated forest reserve, the law is relevant in guiding the handling of vegetation clearance, habitat disturbance, and the conservation of tree species during site preparation and construction. If any valuable or protected tree species are identified within the project area, the law requires proper documentation, mitigation, and in some cases, compensation or reforestation. The Forestry Act also underscores the importance of preventing illegal logging and ensuring sustainable land use practices. For the Birnin Kebbi Road depot project, adherence to this law would involve minimizing deforestation, preserving buffer zones, and integrating green spaces or tree planting in the project's landscaping plan.

National Policy on the Environment 1989 (Revised 1999)

The National Policy on the Environment (1999) provides a comprehensive framework for achieving sustainable development in Nigeria by ensuring that environmental protection is an integral part of all development processes. The policy outlines principles such as the polluter-pays principle, environmental justice, inter-generational equity, and the precautionary principle. In the context of the Birnin Kebbi Road LPG depot, this policy mandates that all environmental risks must be identified, minimized, or mitigated before project implementation. This is typically achieved through the Environmental Impact Assessment (EIA) process, which is a key instrument under the policy. The policy also calls for the adoption of clean technologies, the efficient use of resources, environmental monitoring, and public consultation — all of which are embedded in the project's environmental planning and compliance strategy.

Endangered Species (Control of International Trade and Traffic) Act, Cap. E9 LFN 2004

(Originally Act No. 11 of 1985)

The Endangered Species (Control of International Trade and Traffic) Act, Cap E9 LFN 2004, prohibits the illegal hunting, capture, or trade of endangered flora and fauna. Although the Birnin Kebbi Road project is not sited in a protected forest or wildlife area, the Environmental Impact Assessment (EIA) process must ensure that no endangered species or critical habitats are impacted by land clearing, construction, or operations. If any vulnerable or protected species are found in the project area, mitigation measures such as translocation, habitat conservation, or avoidance strategies must be implemented in compliance with the Act.

Harmful Wastes (Special Criminal Provisions etc.) Act No. 42 of 1988

The Harmful Waste (Special Criminal Provisions) Act No. 42 of 1988 criminalizes the dumping, storage, or transportation of harmful wastes within Nigerian territory without lawful authorization. This Act is critical for gas infrastructure projects, especially those involving industrial chemicals or residuals from equipment flushing and maintenance. The Birnin Kebbi Road project must ensure that all waste—particularly hazardous substances such as lubricants, hydrocarbons, and cleaning agents—is properly managed, stored, transported, and disposed of at approved facilities, under strict supervision and in line with relevant waste management protocols.

EIA Procedural Guidelines, 1995

The EIA Procedural Guidelines (1995), developed by the Federal Ministry of Environment (FMEnv), outline the procedures for conducting Environmental Impact Assessments in Nigeria. These guidelines establish the minimum content of EIA reports, stakeholder consultation requirements, screening processes, impact identification methodologies, and review procedures. For the Birnin Kebbi Road project, adherence to these guidelines ensures a credible, participatory, and legally recognized EIA process that will lead to environmental approval and social license to operate.

Guidelines and Standards for Environmental Pollution Control in Nigeria, 1991

The Guidelines and Standards for Environmental Pollution Control in Nigeria (1991) provide national benchmarks for managing pollution from industrial, commercial, and domestic sources. These standards address air emissions, effluent discharge, solid waste disposal, and noise pollution, setting limits to safeguard human health and the environment. The project must comply with the specified

thresholds for parameters such as carbon monoxide, sulfur dioxide, hydrocarbons, and particulate matter during gas dispensing and engine operations. Similarly, emissions from generators and vehicular traffic must not exceed permissible noise and air quality levels.

National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991 (S.I.No.9)

The National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations (S.I. No. 9 of 1991) place an obligation on industries to adopt cleaner technologies, minimize waste generation, and implement waste reduction at source. The regulation mandates the development of a Waste Management Plan (WMP), proper documentation of waste streams, and adoption of environmentally sound technologies. For the Birnin Kebbi Road depot, compliance involves using vapor recovery systems, leak detection mechanisms, and appropriate containment structures for LPG/LPG handling and storage.

National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991 (S.I.No.15)

The Regulations make provisions for the handling and management of solid hazardous waste. It defines the objectives of hazardous waste management, the functions of appropriate Governmental agencies and the obligations of industries. It also contains the dangerous waste lists and guidance on the management of spills and discharges into the environment. It requires a manifest system for waste that should include information on packaging, labeling and marking. It defines the requirements of ground water protection, surface impoundment, land treatment, waste piles, etc. It also describes the hazardous substances tracking programme with a comprehensive list of acutely hazardous chemical products and dangerous waste constituent. It also states the requirements and procedure for inspection, enforcement and penalty.

National Environmental (Sanitation and Wastes Control) Regulations, 2009, (S.I. No.28)

The purpose of the Regulation is the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution. The Instrument amongst others makes provisions for the control of solid wastes, hazardous wastes and effluent discharges. It in addition, spells out roles and responsibilities of State and Local Government Authorities.

National Environmental (Soil Erosion and Flood Control) Regulations, 2011 (S.I. No.12)

The purpose of these Regulations is to establish technically feasible and economically reasonable

standards and procedures to achieve appropriate level of management and conservation practices to abate soil erosion, siltation and sedimentation of the waters of Nigeria, due to soil erosion and flood aggravated by non-agricultural earth-disturbing activities. Part I of these Regulations apply to general information on soil erosion and flood, while Parts II and III apply to regulated activities to enforce soil erosion and flood control.

National Environmental (Noise Standards and Control) Regulations, 2009 (S.I. No. 35)

The objective of the Regulations is to ensure maintenance of a healthy environment for all people in Nigeria, the tranquility of their surroundings and their psychological wellbeing by regulating noise levels and generally to elevate the standard of living of the people. The Instrument prescribes maximum permissible noise levels of a facility or activity to which a person may be exposed; and provides for the control of noise mitigating measures for the reduction of noise.

The National Environmental Regulations of 2011

The National Environmental Regulations of 2011, which include various sector-specific guidelines issued by NESREA, strengthen the enforcement of environmental laws and provide detailed requirements for environmental audits, waste management, noise control, air quality, and hazardous substances. For a gas facility like Birnin Kebbi Road, these regulations support routine compliance monitoring, reporting, and penalties for violations. While NMDPRA governs the oil and gas sector, overlapping environmental concerns such as noise, biodiversity, and water use remain within NESREA's purview, ensuring inter-agency cooperation on environmental oversight.

National Environmental (Surface and Ground Water Quality Control) Regulations, 2011 (S.I. No. 22)

The purpose of these Regulations amongst others is to protect groundwater sources by regulating the discharge of hazardous wastes, fossil fuels energy and any other substances having the potential to contaminate groundwater. The Regulations also include amongst others, the application and general provisions of water quality standards for various uses such as agriculture, industrial, aquatic life and recreation.

National Guidelines and Standards for Water Quality in Nigeria, FMEnv

The National Guidelines and Standards for Water Quality in Nigeria provide thresholds for drinking water, surface water, and groundwater quality. These standards are vital for the Birnin Kebbi Road project given the potential risk of groundwater or surface water contamination through accidental leaks

or runoff from the facility. Baseline water quality assessments must be carried out as part of the EIA, and operational controls must be implemented to prevent hydrocarbons or chemical contaminants from affecting nearby water sources. The use of impermeable flooring, oil-water separators, and proper stormwater management will be essential compliance strategies.

National Policy on Occupational Safety and Health, 2006

The National Policy on Occupational Safety and Health (2006) aims to protect workers from occupational hazards and promote a safe work environment. The policy is critical to the Birnin Kebbi Road project during both construction and operational phases, where risks such as fire, gas explosion, equipment failure, and exposure to hazardous substances are present. The facility must adopt a robust Health, Safety, and Environment (HSE) management plan, train workers on safe handling procedures, ensure use of Personal Protective Equipment (PPE), and implement emergency response and evacuation protocols.

Land Use Act, Cap. L5 LFN 2004 ***(Originally 1978, Modified 1990)***

The Land Use Act, Cap L5 LFN 2004, vests all land within a state in the Governor, to be held in trust and administered for the use and common benefit of all Nigerians. Under this Act, individuals or corporate entities must obtain a statutory right of occupancy for any land acquired for development purposes. For the Birnin Kebbi Road gas depot project, this implies that ZAGR Ltd. must obtain valid land documentation, including the Certificate of Occupancy (C of O) or equivalent leasehold or customary title converted into a statutory right, duly approved by the Sokoto State Government. In cases involving community land, appropriate consent from traditional leaders or local government authorities is also required. The Land Use Act further mandates fair compensation in situations where land is acquired compulsorily or where livelihoods and assets are affected, thereby aligning with the EIA process and resettlement considerations for project-affected persons (PAPs)..

Labour Act, Cap. L1 LFN 2004 ***(Originally 1990)***

The Labour Act, Cap L1 LFN 2004, governs the terms and conditions of employment in Nigeria, especially as it relates to wages, working hours, employment of women and young persons, contract procedures, and protection of workers' rights. For the Birnin Kebbi Road depot project, which will involve the engagement of both skilled and unskilled labour during construction and operation, the Labour Act ensures that employment contracts are formalized, fair wages are paid, and safety provisions are upheld. The Act prohibits forced labour and outlines procedures for dispute resolution,

unionization, and grievance mechanisms. Moreover, it aligns with international labour standards by mandating safe and healthy working environments, which must be enforced through the project's Health, Safety and Environment (HSE) plan. Contractors and subcontractors engaged in the project must also comply with the Act, particularly concerning the employment of local workers and ensuring equal opportunity practices.

Public Health Law, Cap. P16 LFN 2004 ***(Based on original 1958 version)***

The Public Health Act, Cap P35 LFN 2004, is aimed at preventing and controlling diseases, promoting sanitation, and protecting public health across Nigeria. As it relates to the Birnin Kebbi Road project, this Act provides the legal basis for implementing sanitary controls, waste management, occupational health precautions, and disease surveillance during all phases of project implementation. The Act mandates that any facility which may pose a health risk to nearby residents or workers must adopt strict hygiene and pollution prevention measures. This includes proper handling and disposal of waste (especially used oil, sewage, or medical waste from first aid stations), control of noise and emissions, provision of potable water for workers, and prevention of overcrowding or unsanitary living conditions in worker camps. The Act also supports local health inspections and gives authorities power to enforce compliance or halt operations where public health is endangered.

The Penal Code Law

The Penal Code Law of Northern Nigeria, which is applicable in Sokoto State where the proposed LPG/LPG Depot Project is to be sited, contains several sections that hold relevance to the environmental and social safeguards expected during the project's lifecycle. Each of these sections plays a regulatory role in preventing and punishing misconduct or negligence that may arise during the preconstruction, construction, operational, or decommissioning phases.

Section 196 of the Penal Code addresses the offence of public nuisance. Under this section, any act or omission that causes injury, danger, annoyance, or interference to the comfort or safety of the public is deemed a criminal offence. In the context of the proposed project, public nuisance may arise from unregulated gas emissions, persistent noise, dust generation, or blocking of public roads and access paths during construction or operational activities. If such nuisances are not effectively mitigated, the project promoters or their contractors could be held criminally liable.

Section 190 criminalizes negligent acts likely to spread the infection of disease. This applies particularly to scenarios where environmental health is compromised by poor hygiene, unsanitary waste disposal, or contamination of shared community resources such as water sources. If project

activities lead to the spread of communicable diseases through improper handling of wastewater, human waste, or hazardous materials, they may fall under this penal provision, exposing the responsible parties to prosecution.

Section 207 prohibits the fouling of public water. This section is particularly critical to environmental management as it criminalizes the act of corrupting or polluting water in public springs, rivers, reservoirs, or wells. If the project results in direct or indirect discharge of chemicals, petroleum products, or effluents into natural water bodies used by surrounding communities for drinking or irrigation, it would constitute an offence under this section. The importance of this provision is elevated in rural communities where public health is closely tied to clean water access.

Section 199 is specific to negligent conduct with respect to toxic substances. It criminalizes the handling, storage, or disposal of hazardous or toxic substances in ways that may pose risks to public health or the environment. Given the volatile and combustible nature of LPG and LPG, this section mandates that the project developers ensure adequate safety measures, including proper tank storage, gas leak detection systems, fire suppression systems, and staff training. Any incident such as a gas leak or explosion due to negligence could result in prosecution under this provision.

Section 327 addresses mischief by fire or explosive substances. This provision becomes relevant in high-risk projects such as gas storage and distribution facilities. If due to operational error or sabotage, fire or explosion occurs and causes damage to life or property, the responsible party may be held criminally accountable under this section. This reinforces the need for rigorous adherence to fire safety codes and explosion risk prevention measures at the facility.

Section 245, although not environmental in nature, pertains to unlawful assembly. In situations where community dissatisfaction with the project—perhaps due to land acquisition disputes, unfulfilled corporate social responsibilities, or environmental degradation—leads to protests or resistance, the provisions of this section may come into play. If unrest results from the company's failure to engage the community transparently or mitigate impacts appropriately, it could escalate to civil disturbances for which legal responsibility may arise depending on the context.

1.7.2 International Policy, Guidelines and Conventions

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. 1 – III of 1991. Potential issues considered for EA include the following:

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

IFC Performance Standards on Environmental and Social Sustainability

The International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability describes IFC's commitments, roles and responsibilities related to environment and social sustainability. The performance standards are directed towards clients, providing guidance on how to identify risks and impacts and are designed to help avoid, mitigate and manage risks and impacts as a way of doing business in a sustainable way including stakeholder engagement and disclosure obligations of the client in relation to project level activities. IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced. It sets out eight (8) Performance Standards required by project proponents to meet throughout the life of an investment by IFC.

The Equator Principles, 2003

The 'Equator Principles' are a framework for determining, assessing and managing environmental and social risks in finance transactions for major projects. It comprises a set of principles adopted by the Equator Principles Financial Institutions (EPFIs) to ensure that the projects they finance are developed and implemented in a manner that is socially responsible and environmentally sound. These Equator Principles are a set of voluntary standards that commit the EPFI to the Environmental and Social Performance Standards of IFC.

World Bank Group Environmental, Health, and Safety Guidelines;

World Bank Group Environmental, Health and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of good international industry practice. The EHS guidelines contain the performance levels and measures that are normally acceptable to IFC and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. Two (2) sets of guidelines are used:

- ***The General Environmental, Health and Safety Guidelines***

These Guidelines contain information on cross-cutting environmental, health and safety issues potentially applicable to all industry sectors. They are divided into sections entitled: Environmental; Occupational Health and Safety; Community Health and Safety; Construction; and Decommissioning.

- ***The Industry Sector Guidelines***

These Guidelines contain information on industry-specific impacts and performance indicators, plus a general description of industry activities. The Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution is applicable to the proposed project. It provides guidance applicable to the project facilities that will transmit power from the power station to the nearby distribution substation.

International Labour Organization Conventions on Occupational Safety and Health

Since its foundation in 1919, the International Labour Organization (ILO) has elaborated and adopted a large number of international labour Conventions directly concerned with Occupational Safety and Health (OSH) issues. The ILO Conventions on OSH provide essential tools for government and employers to establish practices that will protect workers from illness, disease and injury that may arise from the workplace, thereby ensuring maximum safety at work. ILO has adopted more than 40 conventions specifically dealing with OSH. However, the applicable conventions ratified by Nigeria include:

- ***Labour Inspection Convention, 1947 (No.81)*** **–** This priority convention sets out a series of principles respecting the determination of the fields of legislation covered by labour inspection, the functions and organizations of the system of inspection, recruitment criteria, the status and terms and conditions of service of labour inspectors, their powers as well as obligations.
- ***Tripartite Consultation (International Labour Standards) Convention, 1976 (No. 144)*** **–** This priority convention sets forth the meaning of "representative organizations" of employers and workers and requires ratifying states to operate procedures that ensure effective consultations between representatives of the government, of employers and of workers on matters regarding OSH. Employers and workers are to be represented on an equal footing on any bodies through which consultations are undertaken.
- ***Occupational Safety and Health Convention, 1981 (No. 155)*** **–** This convention provides for the adoption of a coherent national occupational safety and health policy, as well as action to be taken by governments and within enterprises to promote occupational safety and health and to improve working conditions.
- ***Occupational Health Services Convention, 1985 (No. 161)*** **–** This convention provides for the establishment of enterprise-level occupational health services which are entrusted with essentially

preventive functions and which are responsible for advising the employer, the workers and their representatives in the enterprise on maintaining a safe and healthy working environment. Other applicable ILO OSH Conventions to which Nigeria is not signatory to include:

- *Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148)*
- *Chemicals Convention, 1990 (No. 170)*
- *Safety and Health in Construction Convention, 1988 (No. 167)*
- *Prevention of Major Industrial Accidents, 1993 (NO.174)*

African Convention on the Conservation of Nature and Natural Resources

The African Convention on the Conservation of Nature and Natural Resources was adopted in Algiers, Algeria, on September 15, 1968 and entered into force on June 16, 1969. The Convention stipulates that the contracting States shall undertake to adopt the measures necessary to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people.

Convention Concerning the Protection of the World Cultural and Natural Heritage

The Convention was adopted in Paris, France on October 17, 1972. The Convention sets aside areas of cultural and natural heritage for protection. It places obligations to each State Party to recognize that the duty of ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage situated on its territory, belongs primarily to that State.

Convention on the Conservation of Migratory Species of Wild Animals

This Convention also known as the Bonn Convention was adopted in 1979 and entered into force in 1983. It stipulates actions for the conservation and management of migratory species including habitat conservation.

Vienna Convention for the Protection of the Ozone Layer

The Vienna Convention was adopted in 1985 and entered into force on September 22, 1988. It places general obligations on countries to make appropriate measures to protect human health and the environment against adverse effects resulting from human activities which tend to modify the ozone layer.

The Montreal Protocol on Substances that Deplete the Ozone Layer

The Protocol was adopted on September 16, 1987 as an international treaty to eliminate ozone depleting chemicals production and consumption.

Basel Convention on the Control of Trans-Boundary Movement of Hazardous Wastes and their Disposal

The Convention was adopted on March 22, 1989 and entered into force on May, 1989. It focuses attention on the hazards of the generation and disposal of hazardous wastes. The Convention defines the wastes to be regulated and controlled, warned on their trans-boundary movements in other to protect human and environmental health against their adverse effects.

The United Nations Convention on Biological Diversity

The convention was adopted in 1994. 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.

The United Nations Convention on Climate Change

The Convention on Climate Change was adopted in 1992 during the Rio Earth Summit in Rio De Janeiro, Brazil and entered into force in 1994; to limit Greenhouse Gas (GHG) emissions which cause global warming.

1.7.3 State Policy/ Legislation

In addition to compliance with national environmental and social laws, the proposed LPG station project at Birnin Kebbi Road, must adhere to state and local-level policies, laws, and administrative procedures that govern land use, environmental protection, urban development, and public safety within Sokoto State. While most regulatory powers for oil and gas infrastructure rest with federal agencies such as the Federal Ministry of Environment (FMEnv) and the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA), state and LGA authorities also play important roles, particularly in land allocation, development control, environmental enforcement, community engagement, and local permitting.

Sokoto State Environmental Protection Law and SASEPA

The Sokoto State Environmental Planning and Protection Agency (SASEPA) is the state's key environmental regulatory body. It derives authority from the Sokoto State Environmental Protection Law, which mandates the Agency to:

- Monitor and control industrial emissions, waste disposal, noise, and air pollution.

- Issue environmental compliance certificates and conduct inspections.
- Review Environmental Impact Assessment (EIA) reports submitted for industrial and commercial projects within the state.
- Ensure public health and environmental sustainability across industrial zones.

For the Birnin Kebbi Road gas depot project, SASEPA must be formally notified and involved in the EIA consultation process. The Agency may also review baseline environmental data, participate in field verification, issue a state-level environmental compliance permit, and monitor project compliance post-construction. The project must also follow any local waste disposal laws, noise abatement ordinances, or community safety regulations set by SASEPA.

Sokoto State Urban and Regional Planning Law

This law governs the physical planning and development control within Sokoto State, including zoning regulations, land use planning, and building approvals. The law is implemented by the Sokoto State Urban Planning and Development Authority (KNUPDA), which:

- Approves site plans, building designs, and infrastructure layouts.
- Ensures that projects comply with land-use zoning classifications.
- Issues development permits for commercial and industrial projects.

Given that the LPG and LPG depot involves hazardous materials, the project site and layout must comply with urban planning standards for industrial safety, minimum distances from residential areas, access roads, fire safety zoning, and emergency evacuation routes. The site plan must be reviewed and approved by KNUPDA or any designated town planning office within Bodinga LGA.

Sokoto State Land Use Policies

While the Land Use Act is a federal law, the implementation of land rights and issuance of Certificates of Occupancy (C of O) is administered by the Governor of Sokoto State, through the Ministry of Lands and Physical Planning. For the proposed project:

- Legal acquisition of land must follow Sokoto State land allocation processes.
- The project must possess a valid land title or lease agreement.
- Any conversion from agricultural or residential land to industrial use must be formally approved.

- Customary land within Bodinga LGA must be lawfully transferred to the proponent through the appropriate local authorities and registered at the state level.

1.7.4 Bodinga Local Government By-Laws and Administrative Roles

The Bodinga Local Government Council has administrative authority over local development, community affairs, and rural infrastructure. While the LGA does not enact environmental laws, it performs vital functions such as:

- Granting local construction or business operation permits.
- Facilitating community consultations, engagement with host community, and Project Affected Persons (PAPs).
- Supporting local employment and conflict resolution during project execution.
- Monitoring community health, sanitation, and safety during construction.

The LGA is expected to work in partnership with the project proponent to promote social acceptability, mobilize community feedback, and ensure that compensation, local employment, and development benefits are fairly distributed.

Sokoto State Occupational Health and Safety Directives

While occupational health is mainly governed by federal laws, Sokoto State aligns with national health and safety policies and may issue state-specific health advisories or guidelines particularly through the Sokoto State Ministry of Health and relevant agencies. Any on-site medical unit or public health risk must be reported to local health authorities, especially in cases of gas leaks, explosions, or infectious disease outbreaks among workers.

1.8 STRUCTURE OF THE EIA REPORT

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

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

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

Chapter Three – Project Description –LPG Station and associated activities

Chapter Four – Description of Project Environment- Ecological characteristics of the project

Environment Baseline data acquisition (vegetation, soil, topography, surface water, ground water, sediments etc)

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

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

Chapter Seven -.Environmental Management Plan, - Description of potential impacts matched with mitigation

Chapter Eight–Decommissioning and Abandonment plans

Chapter Nine - Conclusions and Recommendations.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 NEED FOR THE PROJECT

The proposed 200 metric tons Liquefied Petroleum Gas (LPG) Storage and Refilling Plant by Zamson Global Resources Limited, to be sited opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State, is intended to address the increasing demand for reliable and cleaner energy solutions within Sokoto metropolis and surrounding communities. The project aligns with Nigeria's strategic objectives of promoting domestic gas utilization as a means of achieving energy security, environmental sustainability, and long-term economic development.

Although Nigeria possesses significant natural gas resources, access to LPG in many northern states, including Sokoto, remains limited due to insufficient storage and distribution infrastructure. Consequently, households and small enterprises continue to rely heavily on firewood, kerosene, and other carbon-intensive fuels. The establishment of a bulk LPG facility in Bodinga is expected to strengthen the downstream gas supply chain, enhance product availability, and provide a regulated, safe platform for storage and cylinder refilling.

Sokoto State is experiencing steady urban expansion and increasing commercial activities, particularly along key transport corridors such as Birnin Kebbi Road, resulting in rising energy demands across residential, commercial, and light industrial sectors. The proposed LPG plant will help stabilize supply, minimize transportation constraints from distant depots, and reduce unsafe informal refilling operations that pose significant safety hazards to the public.

At the community level, the project is anticipated to generate employment opportunities during both the construction and operational phases, while also fostering ancillary businesses such as cylinder distribution, logistics, and retail services. Revenue generated from permits, levies, and taxes will further support local and state government finances. Additionally, improved access to LPG is expected to encourage cleaner cooking practices, reduce indoor air pollution, alleviate pressure on forest resources, and enhance overall environmental quality and public health within the host community

2.2 BENEFITS OF THE PROJECT

The proposed 200 metric tons Liquefied Petroleum Gas (LPG) Refilling Plant in Bodinga Local Government Area of Sokoto State is expected to generate substantial socio-economic, environmental, and strategic benefits at the local, state, and national levels. The project aligns with Nigeria's gas-based energy transition policy and advances broader sustainable development goals.

A primary benefit of the project is the expansion of access to cleaner energy. LPG is recognized as a low-emission fuel compared to firewood, kerosene, petrol, and diesel. By improving the availability and accessibility of LPG within Sokoto metropolis and surrounding communities, the project will reduce reliance on biomass and other carbon-intensive fuels, lower indoor and outdoor air pollution, and minimize greenhouse gas emissions. Increased adoption of LPG for domestic and commercial purposes will also help conserve forest resources and improve public health outcomes.

Economically, the project will stimulate local development by creating both direct and indirect employment opportunities. Jobs will be generated during site preparation and construction, engaging engineers, technicians, artisans, drivers, and laborers. Once operational, the facility will offer permanent employment in areas such as plant management, cylinder handling, safety supervision, maintenance, sales, and security. Additional indirect opportunities will arise in transportation, cylinder distribution, retail operations, and ancillary services. Where feasible, priority will be given to qualified residents of Bodinga LGA, thereby supporting local income generation and skills development.

From an infrastructure standpoint, the plant will strengthen downstream LPG distribution across Sokoto State by decentralizing storage and supply. This will reduce reliance on distant depots, improve product availability, lower transportation risks, and contribute to price stability. A more reliable LPG supply is also expected to encourage broader adoption of gas-powered appliances and energy solutions in both domestic and commercial sectors.

The project will further contribute to government revenue through statutory taxes, levies, and operational permits payable to Sokoto State and Bodinga Local Government authorities, supporting public services and infrastructure development.

Socially, improved LPG access will provide households with a safer and more efficient cooking fuel alternative. Reduced exposure to smoke and harmful emissions from traditional fuels will enhance respiratory health, particularly for women and children, who are most vulnerable to indoor air pollution.

2.3 ENVISAGED SUSTAINABILITY

The proposed project has been conceptualized with sustainability principles embedded in its planning, design, and operational framework. The project integrates economic strength, environmental responsibility, technical reliability, and social inclusion to ensure long-term viability and minimal adverse impacts.

2.3.1 Economic Sustainability

The long-term viability of the proposed LPG Storage and Refilling Plant is supported by the increasing demand for LPG as a reliable domestic and commercial energy source in northern Nigeria. As Nigeria intensifies efforts to expand gas utilization, the facility is strategically positioned to meet the growing energy needs of Sokoto metropolis and surrounding communities. Its location along Birnin Kebbi Road provides logistical advantages, ensuring efficient product distribution and accessibility to consumers.

The project is expected to generate stable revenue through bulk storage and cylinder refilling services while creating both direct and indirect employment opportunities. Participation of local contractors, transport operators, and service providers will enhance economic linkages within Bodinga LGA. In addition, statutory payments including taxes, operational permits, and regulatory fees will contribute to state and local government revenue, thereby strengthening the project's long-term economic and commercial sustainability.

2.3.2 Environmental Sustainability

Environmental protection is a key consideration in the planning and operation of the proposed LPG Storage and Refilling Plant. Compared to traditional fuels such as firewood, kerosene, petrol, and diesel, LPG is a cleaner-burning energy source that generates lower levels of air pollutants and greenhouse gas emissions. Wider use of LPG within Sokoto metropolis and surrounding communities will help reduce indoor air pollution, curb carbon emissions, and lessen the demand for firewood, thereby supporting forest conservation.

The project design integrates multiple environmental safeguards, including paved operational areas, spill containment systems, fire suppression equipment, and regular monitoring of air, soil, and water quality. Operational practices will emphasize pollution prevention, safe handling of LPG products, and emergency preparedness to protect the surrounding environment and ensure compliance with national regulations and industry standards.

2.3.3 Technical Sustainability

The plant will utilize durable, industry-approved LPG storage tanks and dispensing systems designed to meet recognized safety and engineering standards. Built-in safety mechanisms—including gas detection devices, pressure control systems, and fire suppression equipment—will ensure operational integrity.

Preventive maintenance schedules, staff training programmes, and periodic technical inspections will enhance system reliability and extend infrastructure lifespan. The design also allows flexibility for future capacity expansion in response to increasing demand, ensuring the facility remains functional and relevant over time.

2.3.4 Social Sustainability

The project promotes social well-being by improving access to safe and affordable cooking fuel for households and businesses in Sokoto State. Reduced reliance on firewood and kerosene will contribute to improved respiratory health and better living conditions, particularly for women and children.

Continuous stakeholder engagement with host communities and local authorities will foster transparency and cooperation. Employment preference for qualified local residents, community safety awareness programmes, and an accessible grievance redress mechanism will strengthen community relations and promote long-term social acceptance of the project.

2.4 ANALYSIS OF PROJECT OPTIONS AND ALTERNATIVES

In line with Environmental Impact Assessment requirements, different development alternatives were examined for the proposed project. The objective was to identify the most suitable option that achieves project goals while minimizing environmental and social risks.

1. No-Project (Status Quo) Alternative

Under this scenario, the LPG facility would not be constructed and the current energy supply pattern would remain unchanged.

Implications:

- Continued reliance on firewood, kerosene, and other high-emission fuels.
- Ongoing pressure on forest resources and exposure to indoor air pollution.
- Loss of employment opportunities and reduced economic stimulation within Bodinga LGA.

- Failure to strengthen local gas distribution infrastructure.

Conclusion:
The no-project option does not address growing energy demand or environmental concerns and would deny the community the socio-economic benefits associated with the project. It is therefore not considered desirable.

2. Alternative Location Option

Consideration was given to siting the project in another part of Sokoto State. Key evaluation criteria included accessibility, land compatibility, environmental sensitivity, proximity to consumers, and community acceptance.

Assessment of the Proposed Site:

- Located along Birnin Kebbi Road with good vehicular access for supply trucks and customers.
- Land use characteristics are compatible with commercial and light industrial activities.
- No critical ecological habitats or protected areas are affected.
- Positive disposition of local stakeholders toward the project.

Conclusion:
The selected site in Bodinga LGA offers logistical convenience, technical feasibility, and social acceptance. Relocating the project would likely increase costs and delay implementation without providing significant environmental advantages.

3. Alternative Design and Technology Options

Various engineering and operational configurations were reviewed to ensure safety and efficiency.

- **Storage System:** Above-ground LPG tanks were selected due to ease of inspection, maintenance, and regulatory compliance.
- **Dispensing Method:** A controlled dispensing system with integrated safety valves and monitoring devices was preferred to enhance operational safety.
- **Safety Infrastructure:** Installation of fire-fighting equipment, gas detection systems, and emergency shut-off valves, and secure perimeter fencing forms part of the selected design.

Conclusion:

The adopted design prioritizes safety, operational efficiency, and environmental protection while remaining cost-effective and adaptable to future expansion.

4. Product Configuration Alternative

The option of integrating additional petroleum products was assessed. However, a dedicated LPG facility was preferred in order to simplify operational management, reduce safety complexity, and focus on promoting clean energy adoption within the area.

Preferred Alternative

Based on technical, environmental, economic, and social considerations, the preferred option is the development of a dedicated LPG Refilling Plant at the proposed Bodinga site using above-ground storage systems and modern safety technologies. This alternative best satisfies project objectives, enhances clean energy access, and aligns with sustainable development priorities in Sokoto State.

CHAPTER THREE

PROJECT DESCRIPTION

3.1 SCOPE OF WORK

The proposed project by Zamson Global Resources Limited entails the development of a modern, fully integrated Liquefied Petroleum Gas (LPG) Storage and Refilling Plant along Birnin Kebbi Road in Bodinga Local Government Area, Sokoto State. The facility is designed to cover all stages of the project lifecycle, including site preparation, construction, commissioning, and long-term operations. It will serve as a strategic hub for the receipt, storage, conditioning, and distribution of LPG to domestic, commercial, and industrial consumers across Sokoto State and the wider northern region.

The facility will feature advanced gas handling and dispensing infrastructure, including a high-pressure modular LPG storage tank with a bulk capacity of 200 metric tons. It will be equipped with eight (08) electronically controlled refilling units capable of dispensing LPG into cylinders ranging from 6 kg to 35 kg for household and commercial purposes, as well as larger cylinders for industrial applications.

To ensure safe, efficient, and regulated operations, the plant will integrate essential gas management and conditioning systems, including odorization units, vaporizers where necessary, pressure regulation systems, and pump skid assemblies. These components will help maintain product quality, enhance operational safety, and enable controlled LPG distribution in accordance with industry standards and best practices.

Supporting infrastructure will include a fully equipped electrical control room powered by a 250 kVA standby generator, backed by a grid-connected transformer. Fire safety measures will comprise a dedicated firewater system with diesel, electric, and jockey pumps, supplemented by dry chemical and CO_2 extinguishers, sand buckets, hazard signage, and designated buffer zones in line with NFPA standards (NFPA 52 and NFPA 59A). The facility will also incorporate stormwater drainage, underground utilities, septic systems, and reinforced hardstand surfaces to ensure operational resilience and environmental protection.

Administrative and support facilities have been planned to enhance operational efficiency and user experience. These include an administrative block with offices, reception areas, restrooms, staff changing rooms, a mini-mart, waiting areas for customers, a technical workshop, storage facilities, and

a mosque to meet spiritual needs. Security will be ensured through a controlled entry point with sliding gates.

The site, encompassing approximately 20,000 square meters, has been designed to accommodate smooth vehicular circulation, including large delivery trucks and customer vehicles. Internal roads are constructed to handle heavy loads of up to 80 tonnes, with separate lanes allocated for operational, administrative, and emergency access, ensuring both safety and efficiency throughout the facility.

The project will be executed in four main phases:

1. **Pre-construction** – site surveys, regulatory approvals, and baseline environmental studies;
2. **Construction** – civil, mechanical, and electrical works;
3. **Commissioning** – system testing, safety certification, and staff training;
4. **Operational Phase** – daily LPG storage, cylinder refilling, distribution, maintenance, and ongoing environmental monitoring.

Fig 3.1: Facility Layout Plan of the Project Site

3.2 PROJECT OVERVIEW

The proposed project by Zamson Global Resources Limited entails the development of a modern Liquefied Petroleum Gas (LPG) Storage and Refilling Plant along Birnin Kebbi Road, Bodinga Local Government Area, Sokoto State. The initiative aligns with the Federal Government's National Gas

Expansion Programme (NGEP), which seeks to transition Nigeria from conventional petroleum fuels to cleaner, safer, and more sustainable energy sources. The project is designed to meet the growing demand for affordable and environmentally friendly energy in Sokoto State and the broader northern region, particularly for domestic, commercial, and vehicular applications.

The facility, spanning approximately 10,000 square meters, will function as a primary LPG hub for storage, compression, and distribution. LPG will be delivered to the site via road tankers and compressed using high-pressure systems for direct refueling of vehicles as well as for onward loading into distribution trucks serving satellite stations. This arrangement will improve fuel availability, reduce reliance on petrol and diesel, support the adoption of LPG-powered vehicles, enhance air quality, and comply with national safety and environmental regulations.

Key infrastructure components include high-pressure storage vessels certified to ISO standards, with a combined capacity of 200 metric tons, and gas compressor units capable of pressurizing LPG for safe dispensing and onward distribution. Safety features such as pressure relief valves, emergency shutdown systems, and automated monitoring are integrated to ensure efficient and secure operations.

The dispensing and metering system comprises dedicated refueling bays equipped with leak-proof high-pressure hoses, double nozzles for simultaneous vehicle fueling, and automated meters to guarantee accurate measurement and billing. Operational control is maintained via pressure regulators, automatic shut-off valves, and a programmable logic control (PLC) panel for real-time monitoring and management.

Fire protection and safety measures are embedded throughout the facility, including strategically placed fire hydrants and extinguishers, gas detection and alarm systems, emergency assembly points, and perimeter fencing with controlled access to enhance both safety and security.

Ancillary infrastructure will support operational efficiency and staff welfare. This includes an administrative block with offices, a control room, and staff facilities, a reliable power supply through both grid connection and backup generator, an on-site borehole for water supply, and a drainage network to manage wastewater and stormwater. Paved access roads, reinforced forecourts, adequate lighting, and safety signage will facilitate smooth vehicle circulation and operational effectiveness.

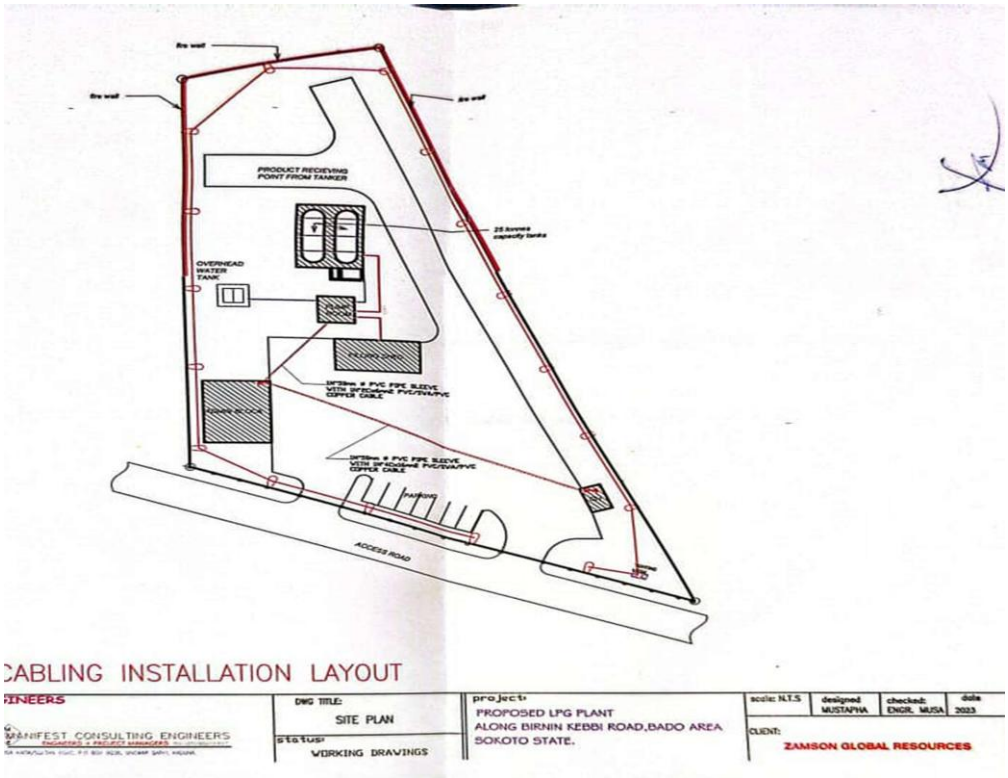


Figure 3.2: Facility Layout of the Project

The proposed LPG Storage and Refilling Plant is expected to contribute significantly to energy diversification in Sokoto State by enhancing access to cleaner fuels for domestic, commercial, and transportation applications. The project will also drive economic growth by generating employment during both the construction and operational phases and by stimulating related downstream activities such as cylinder distribution, logistics, and ancillary service operations.

In keeping with Zamson Global Resources Limited's commitment to environmental stewardship and regulatory compliance, a thorough Environmental Impact Assessment (EIA) will be carried out in accordance with the guidelines of the Federal Ministry of Environment (FMEnv). The assessment will examine potential environmental and social impacts, identify sensitive receptors, and propose appropriate mitigation and monitoring measures to ensure effective environmental management throughout the project lifecycle.

The project incorporates several environmental management measures, including a stormwater drainage system to manage runoff and prevent flooding, waste management facilities for proper segregation and disposal of solid and liquid wastes, and an oil-water separator to avoid hydrocarbon contamination of surface and groundwater. A landscaped green buffer zone will also be established within the site to enhance aesthetics, reduce dust, attenuate noise, and improve compatibility with the surrounding community.

3.3 EQUIPMENT CONSIDERATION

Table 3.1: Major Equipment and Systems to be Installed for the LPG Facility

Sr. No.	Equipment Description	Capacity
1	Cryogenic Vertical LNG Storage Tank Skid	114 m³ / 110 m³
2	LNG Loading / Unloading Skid	—
3	LNG Pump Skid	20 m³/hr
4	Tank Pressure Building Unit (PBU) Skid	400 Nm³/hr
5	LNG Dispenser	80 kg/min
6	LLPG Pump Skid	2,500 L/hr
7	LNG High-Pressure Vaporiser	1,500 Nm³/hr
8	LPG Cascade Storage Tanks	8 × 1.33 m³
9	Priority Panel	—
10	Odorizer Unit	—
11	Odorization Skid	—
12	LPG Dispenser (Cars and Trucks)	—
13	EAG Vaporisers (Low Pressure & High Pressure)	300 Nm³/hr each
14	Boil-Off Gas (BOG) Vaporiser and Regulating Skid	100 Nm³/hr
15	Boil-Off Gas (BOG) Compressor	100 Nm³/hr
16	Vent Stack	—
17	Gas Generator	250 kVA
18	LPG Cascade Filling Post	4,000 Nm³/hr
19	Fire Water System (Diesel Pump, Electric Pump & Jockey Pump)	—

3.4 PRODUCTION AND COMPRESSION PROCESS

The production and compression process at the proposed LPG Storage and Refilling Plant is designed to ensure safe handling, storage, compression, and distribution of Liquefied Petroleum Gas (LPG). The system is structured to meet operational efficiency standards while complying with national safety and environmental regulations.

3.4.1 Receipt of LPG

LPG will be transported to the facility through certified road tankers from approved suppliers. Upon arrival, the tankers will undergo safety inspection before offloading. The offloading process will be carried out through designated discharge points fitted with high-pressure flexible hoses, grounding systems to prevent static electricity, and pressure gauges for monitoring. Strict operational procedures will be followed to prevent leakages, spills, or overfilling.

3.4.2 Bulk Storage System

The received LPG will be transferred into ISO-certified high-pressure storage tanks with a combined capacity of approximately 50 metric tons. These tanks are designed to withstand operational pressure and temperature variations. Each tank will be fitted with pressure relief valves, level indicators, temperature sensors, and emergency shut-down systems to ensure safe storage conditions.

Figure 3.3: Storage System of LPG

3.4.3 Gas Compression Process

LPG intended for refilling and distribution will pass through high-pressure compressor units. The compressors increase and regulate pressure to meet dispensing and transfer requirements. The compression system will be controlled using a programmable logic control (PLC) system that enables real-time monitoring of pressure levels, temperature, and flow rate. Automatic shutdown mechanisms will activate in case of abnormal pressure or leakage detection.

3.4.4 Cylinder Refilling and Truck Loading

Compressed LPG will be dispensed into cylinders of various capacities such as 6 kg, 12 kg, 25 kg, and 35 kg using automated refilling machines equipped with calibrated metering systems. Dedicated dispensing bays with double nozzles will allow simultaneous filling operations. For bulk distribution, daughter trucks will be loaded through high-pressure transfer lines designed to prevent leakage and ensure safe transfer.

3.4.5 Safety and Control Measures

The facility will incorporate multiple safety systems throughout the production and compression process. These include gas detection and alarm systems, emergency shut-off valves, fire extinguishers, fire hydrants, and pressure relief devices. The entire process will be continuously monitored from the control room to ensure compliance with operational safety standards.

3.4.6 Supporting Utilities

Supporting infrastructure such as standby power generators, an on-site borehole for water supply, stormwater drainage channels, and oil-water separators will ensure uninterrupted operation and environmental protection. These systems are integrated into the overall plant design to enhance safety, efficiency, and sustainability.

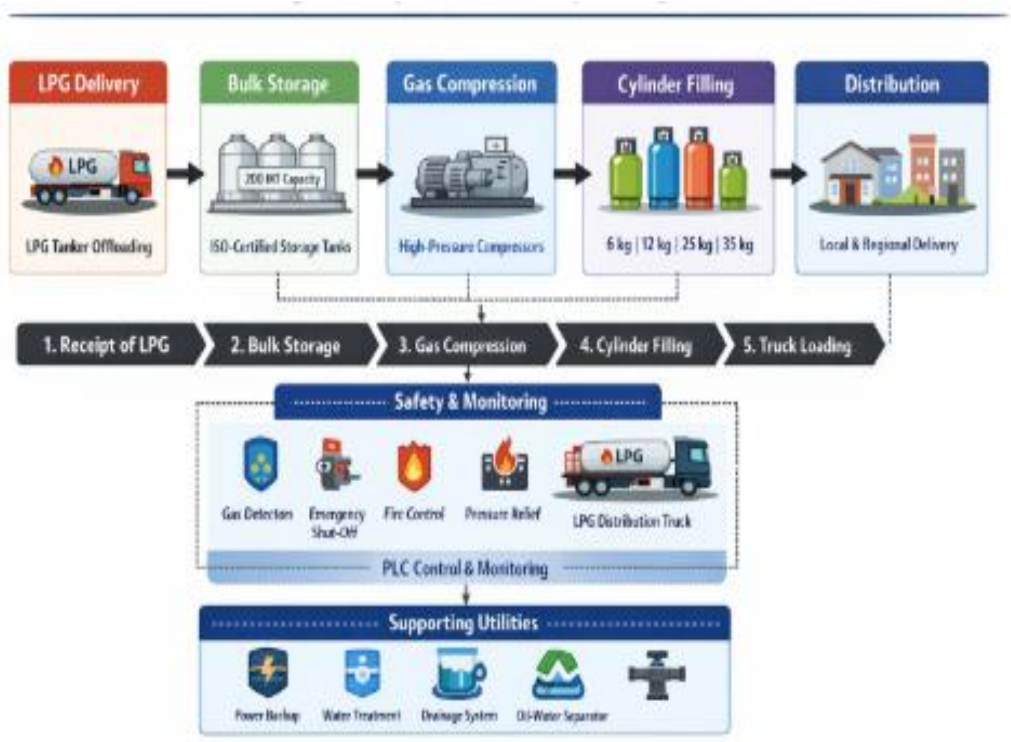


Figure 3.4: LPG Storage, Compression and Dispensing Process

3.5 PROJECT ACTIVITIES

The proposed Liquefied Petroleum Gas (LPG) Dispensing station at Bodinga Local Government Area, Sokoto State, to be developed by ZAGR, will be implemented through a well-defined and systematic project execution framework. The project activities are organized into four main phases, namely Pre-construction, Construction, Commissioning and Operations, and Decommissioning. Each phase has

been structured to ensure technical efficiency, environmental protection, public safety, and full compliance with applicable national regulatory requirements.

3.5.1 Pre-construction Phase

The pre-construction phase constitutes the planning and preparatory stage of the proposed LPG project. It includes all baseline studies, technical evaluations, and statutory processes required prior to the commencement of physical development on site. Activities undertaken at this stage include site appraisal and selection, detailed topographic surveys, and geotechnical investigations to assess soil suitability and foundation requirements for LPG infrastructure.

This phase also involves the preparation of engineering and architectural designs, process layouts, and construction drawings for the proposed LPG dispensing facility. Regulatory approvals and permits are obtained from relevant authorities, particularly the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) and the Federal Ministry of Environment (FMEnv).

A key activity during this phase is the conduct of a comprehensive Environmental Impact Assessment (EIA) in accordance with FMEnv guidelines. The EIA is aimed at identifying potential environmental and social impacts associated with the proposed LPG facility, evaluating sensitive receptors within the project area, recommending appropriate mitigation measures, and incorporating stakeholder inputs through public consultation and disclosure processes. Other preparatory activities include project cost estimation, development of construction schedules, equipment specifications, and mobilization plans.

Procurement arrangements for major LPG-related equipment such as compressors, cascade storage vessels, pressure regulation systems, vaporizers, and dispensing units are also initiated during this phase. The pre-construction stage concludes with site clearing, setting-out of project components, and mobilization of contractors, personnel, and equipment to the project location.

3.5.2 Construction Phase

The construction phase covers all civil, mechanical, electrical, and instrumentation works required to achieve full physical development of the LPG dispensing depot. Initial activities include site clearing, earthworks, land leveling, excavation, and construction of drainage systems to manage surface runoff and prevent flooding.

Civil and structural works involve the construction of foundations for LPG cascade storage tanks, compressor skids, dispensing bays, control room, administrative offices, workshop, security post, and

other ancillary facilities. Additional infrastructure such as paved forecourts, access roads, parking areas, and perimeter fencing are also developed during this phase.

Mechanical and process installations follow, including the installation of LPG compressors, cascade storage tanks, pressure reduction units, vaporizers, priority panels, odorization systems, and dispensing equipment for light and heavy-duty vehicles. Electrical and instrumentation works include the installation of transformers, power distribution systems, lighting facilities, control panels, fire detection systems, and emergency shutdown devices. Supporting utilities such as septic tanks, stormwater drains, cable trenches, and water supply systems are also completed.

Throughout the construction phase, strict health, safety, and environmental (HSE) measures are implemented to prevent accidents, control dust and noise emissions, and ensure proper handling and disposal of construction waste. Continuous supervision, environmental monitoring, quality assurance checks, and compliance inspections are conducted to ensure that all construction activities conform to approved designs, safety standards, and regulatory requirements.

List of Construction Equipment

The following is a detailed list of construction equipment anticipated for use during the development of the Liquefied Petroleum Gas (LPG) Dispensing Depot by ZAGR at Bodinga Local Government Area. These machines and tools will support activities spanning site preparation, civil construction, mechanical installations, and electrical infrastructure setup.

Site Preparation and Earthmoving

- **Bulldozers:** Utilized for clearing vegetation, leveling ground, and rough grading of the site.
- **Excavators:** Employed for digging trenches, foundations, and pits for septic tanks and sumps.
- **Wheel Loaders:** Used to load and transport soil, gravel, and other bulk materials around the site.
- **Backhoe Loaders:** Handy for smaller excavation tasks and loading materials in confined areas.
- **Graders:** For precise leveling and preparing road bases.
- **Compactors/Rollers:** To compact soil and stabilize surfaces for construction.

Civil Construction Equipment

- **Concrete Mixers (Mobile and Stationary):** For on-site mixing of concrete to be used in foundations and structural works.
- **Concrete Pumps:** To transfer concrete efficiently into formworks and construction molds.

- **Cranes (Mobile and Tower):** For lifting heavy structural components and positioning storage tanks or equipment.
- **Scaffolding and Formwork Systems:** Essential for supporting reinforced concrete casting and building works.
- **Dump Trucks:** To transport excavated materials, sand, gravel, and construction debris.

Mechanical and Piping Installation Tools

- **Hydraulic Lifting Equipment/Forklifts:** For moving and installing heavy compressors, vaporizers, and pump units.
- **Pipe Bending Machines:** To accurately shape and align gas pipelines.
- **Welding Machines (TIG, MIG, Arc):** For joining metal components and piping systems.
- **Air Compressors:** To power pneumatic tools and clean pipework during installation.
- **Grinding and Cutting Tools:** For metal preparation and pipe fitting works.

Electrical and Utility Installation Equipment

- **Cable Pulling Machines:** To facilitate the laying of underground and overhead electrical cables.
- **Portable Generators:** Provide temporary power supply during the construction phase.
- **Electrical Testing Equipment:** Used for insulation resistance, continuity, and grounding tests to ensure system safety.
- **Lighting Towers:** To provide adequate illumination during low-light or night-time construction activities.

Safety and Logistics Equipment

- **Water Tankers:** Employed for dust suppression on site and for curing concrete surfaces.
- **Fire Extinguishers:** Strategically placed to manage fire risks during welding and mechanical operations.
- **First Aid Kits and Safety Stations:** For onsite emergency medical response and health safety.
- **Site Fencing and Signage:** To control site access and clearly mark hazards for personnel safety.

Miscellaneous Tools and Instruments

- **Hand Tools:** Including hammers, shovels, spades, wrenches, pliers, and other essential manual tools.

- **Surveying Equipment:** Such as total stations, theodolites, and GPS devices for precise site layout and measurement.
- **Portable Storage Containers:** For secure storage of tools, equipment, and construction materials.

3.5.3 Operation and Maintenance

Following the completion of construction, the project will move into the commissioning and operational phase. Commissioning will involve comprehensive testing of all equipment and systems to verify that they function safely, efficiently, and according to design specifications. This will include pressure testing of pipelines, leak detection procedures, calibration of dispensing units, inspection of safety devices, and integration checks across mechanical, electrical, and control systems.

Training of operational personnel will be a key focus during this phase, covering emergency response, equipment operation, safety compliance, and standard operating procedures. Once commissioning is successfully completed, the LPG depot will become fully operational, providing fuel dispensing services to commercial vehicles, private users, and facilitating the loading of daughter trucks for further distribution.

Throughout the operational phase, the facility will be managed by skilled technical and administrative staff who will conduct regular maintenance and inspections to ensure reliability and minimize downtime. Continuous environmental monitoring, emissions tracking, and ongoing engagement with the local community will help sustain environmental performance and foster positive corporate-community relations. The facility's emergency response plan will be periodically tested to maintain preparedness for incidents such as fires, gas leaks, or other emergencies.

Prior to commissioning, all mechanical systems including storage vessels, pipelines, valves, and compressors will undergo hydrostatic testing to verify pressure integrity and identify any leaks or structural weaknesses. Potable-quality water for hydrotesting will be sourced from an approved borehole on site or from nearby surface water sources.

An estimated volume of 250,000 to 300,000 liters of water will be required to conduct these tests. To prevent internal corrosion during testing, a biodegradable corrosion inhibitor (such as sodium nitrite or phosphate-based additives) will be added; no toxic or bio-cidal substances will be used.

Hydro-test water will be temporarily stored in holding tanks or Intermediate Bulk Containers (IBCs) to facilitate quality testing after discharge. Parameters such as pH, temperature, oil/grease content, and

suspended solids will be monitored to ensure compliance with environmental standards. Where necessary, pre-treatment processes like sedimentation and filtration will be applied before water discharge. Treated water will be released via soak-away pits or directed to engineered grassy infiltration fields, ensuring no untreated water enters surface water bodies or storm drains.

3.5.4 Decommissioning Phase

The decommissioning phase signifies the conclusion of the project's lifecycle, whether due to the end of its economic viability, relocation, or replacement with new infrastructure. This stage involves the safe dismantling and removal of all gas processing equipment, storage tanks, pipelines, and ancillary structures.

All hazardous materials will be identified and disposed of in accordance with prevailing environmental regulations and waste management protocols. Site rehabilitation will be undertaken to restore the land to its original or an agreed-upon post-project condition, which may include soil remediation, landscaping, and sealing of underground installations.

Utility connections will be properly disconnected, and any remaining gas safely vented or recovered. A detailed decommissioning plan, prepared in advance and approved by relevant regulatory authorities, will ensure that all activities are conducted with utmost care to safeguard human health, environmental integrity, and the interests of the local community.

Figure 3.5: LPG Storage Facility with Safety Station

3.6 WASTE MANAGEMENT

The construction and operation of the proposed LPG Dispensing station in Bodinga LGA, will generate various solid, liquid, and gaseous wastes. Understanding the types, sources, classifications, and volumes of these wastes throughout the project lifecycle is vital to developing effective management strategies that comply with environmental regulations and prevent pollution of air, soil, and water resources. This section outlines the waste profile across the pre-construction, construction, commissioning/operation, and decommissioning phases.

3.6.1 Waste during the Pre-construction Phase

Types and Sources

Waste generation during pre-construction is minimal, mostly arising from site clearing and initial field activities. Expected wastes include cleared vegetation, topsoil, packaging materials from survey equipment, and domestic waste generated by field personnel.

Classification and Estimated Volume:

- *Biodegradable Waste:* Cleared vegetation and organic matter (moderate volume)
- *Non-hazardous Solid Waste:* Paper, cardboard, and food waste (low volume)
- *Inert Waste:* Excavated topsoil and stones (moderate volume)

Management Approach

Cleared vegetation will be mulched or composted where feasible, while usable topsoil will be stockpiled for later landscaping or site restoration. Non-hazardous wastes and domestic refuse will be collected in designated containers and transported to approved local disposal sites. All waste handling will be closely supervised to ensure proper segregation and minimize environmental impacts.

3.6.2 Waste during the Construction Phase

Types and Sources

Construction activities will produce various solid and liquid wastes from civil works, mechanical and electrical installations, and workforce operations. Major waste sources include packaging, pipe and metal off-cuts, cement bags, paint containers, welding residues, scrap wood, oily rags, and domestic refuse.

Classification and Estimated Volume:

- *Hazardous Waste:* Used oils, lubricants, paint residues, solvents, oily rags (low to moderate volume)
- *Non-Hazardous Construction Waste:* Scrap metals, concrete debris, plastics, timber, insulation materials (moderate to high volume)
- *Sanitary/Domestic Waste:* Food scraps, paper, plastics (moderate volume)
- *Wastewater:* From equipment cleaning and concrete mixing (moderate volume)

Management Approach

Hazardous wastes will be securely stored in labeled, sealed containers and transported to licensed waste management facilities for proper disposal or recycling. Non-hazardous construction debris will be sorted for reuse when possible (e.g., timber for formwork) or disposed of at authorized landfills. Concrete wash water will be treated in sedimentation basins to prevent watercourse contamination. Sanitary waste from workers will be managed through mobile toilets or septic systems.

3.6.3 Waste during Commissioning and Operational Phases

Types and Sources

Operational waste will arise from routine maintenance, equipment servicing, facility inspections, and administrative activities. Common waste includes used filters, expired fire extinguishers, packaging materials, used personal protective equipment (PPE), oily rags, spent lubricants, and general office refuse.

Classification and Estimated Volume:

- *Hazardous Waste:* Spent lubricants, used filters, residues from gas leaks, contaminated PPE (low volume but ongoing)
- *Non-Hazardous Waste:* Paper, packaging, food scraps, plastic bottles, office waste (moderate volume)
- *Sanitary Waste:* From staff and visitors (moderate volume)
- *Gaseous Emissions:* Minor methane leaks and emissions from gas-powered generators (low but controlled)

Management Approach

A comprehensive waste management plan will be enforced, including routine waste audits, source segregation, and regular removal by certified waste contractors. Hazardous wastes will be stored securely in ventilated areas and disposed of per NMDPRA and NESREA regulations. Recyclable materials such as plastics, paper, and metals will be collected separately for recycling. Gas emissions will be continuously monitored via leak detection systems, and regular maintenance will help minimize fugitive emissions.

3.6.4 Decommissioning Phase

Waste Types and Sources

At the conclusion of the depot's operational life, the decommissioning process will generate substantial waste volumes from the dismantling and removal of storage tanks, pipelines, dispensers, electrical installations, and building structures. Additionally, materials contaminated during operations and residual gases will require careful management.

Classification and Estimated Volume

- *Hazardous Waste:* Residual gases trapped in pipelines, decontaminated processing equipment, and chemical residues (moderate to high volume)
- *Non-Hazardous Waste:* Scrap metals, concrete debris, dismantled electrical parts, and demolition waste from buildings (high volume)
- *Contaminated Soil:* Potentially impacted soil from leaks or spills during depot operation (volume depends on site conditions)

Management Approach

Decommissioning activities will be carried out following a comprehensive waste disposal and site rehabilitation plan. All pipelines and equipment will be thoroughly purged and flushed to remove residual gases. Salvageable materials such as metal structures and tanks will be recovered for reuse or recycling, while non-recyclable wastes will be transported to authorized disposal sites approved by relevant government agencies. Contaminated soils identified during site assessment will be excavated and treated following environmental remediation standards. The site will subsequently be restored through backfilling, grading, and re-vegetation to ensure it returns to a safe and stable condition.

Table 3.2 Summary of Waste Management Strategy for the LPG Dispensing Depot

Phase	Waste Type	Classification	Expected Volume	Management Technique
Preconstruction	Cleared vegetation, excavated soil	Biodegradable / Inert	Low to Moderate	Composting vegetation, stockpiling topsoil for reuse, local disposal of non-reusable waste
Construction	Scrap metal, used oils, oily rags, welding slag	Hazardous / Non-Hazardous	Moderate to High	Segregation of hazardous and non-hazardous waste, recycling where possible, disposal via licensed contractors
Operations	Spent lubricants, used PPE, contaminated filters, paper waste	Hazardous / General Waste	Low to Moderate	Routine collection and segregation, recycling of materials, hazardous waste managed per regulatory protocols
Decommissioning	Dismantled metal components, residual gas residues, contaminated soils	Hazardous / Non-Hazardous	Moderate to High	Equipment decontamination, salvage and recycling of metals, soil remediation, and full site rehabilitation

3.7 PROJECT SCHEDULE

The construction phase of the project is expected to last up to 12 months after all required permits and approvals have been obtained from the appropriate regulatory authorities. The detailed project timeline will be finalized upon completion of the EIA process.

Following construction, performance and operational testing will be conducted, after which the facility will commence full operations. The projected operational lifespan of the project is approximately 30 years, at the end of which the facility and its associated infrastructure will be properly decommissioned.

Table 3.3: Project Implementation Schedule for the Proposed LPG Refilling plant in, Bodinga LGA

Month	Project Phase / Activity	Responsibility
1	Project mobilization and kickoff meetings for the proposed LPG Refilling plant in Bodinga	Project Manager / ZAGR
	Site confirmation, final land acquisition, and documentation	Legal / Surveying Unit
	Baseline Environmental Impact Assessment (EIA) studies and stakeholder consultations within Bodinga community and adjoining areas	Environmental Consultant
	Conceptual engineering design and preliminary approvals	Engineering Team / Consultants
2	Preparation, reporting, and submission of EIA report to the Federal Ministry of Environment (FMEnv)	EIA Consultant / ZAGR
	Detailed engineering design of LPG facility	Engineering Contractor
	Permit and regulatory applications (NMDPRA, KASEPA, Fire Service, etc.)	ZAGR Regulatory Team
3	Environmental approval and permit issuance	FMEnv / NMDPRA
	Equipment specification and initiation of procurement process	Procurement Team
	Site preparation and vegetation clearing in line with approved EIA mitigation measures	Civil Works Contractor
4	Civil works including fencing, drainage systems, and foundation construction	Civil Works Contractor
	Off-site fabrication of LPG tanks, skids, and associated systems	OEM / Fabricator
5	Structural construction of administrative block and control room	Structural Engineer
	Installation of septic system, sump pits, and stormwater drainage	Plumbing / Civil Team
6	Installation of underground piping, electrical cabling, and service trenches	Mechanical / Electrical Teams
	Delivery of major equipment (LPG storage tanks, compressors, pumps)	Vendor / Logistics Team
7	Mounting and installation of storage tanks, skids, and cascade systems	Equipment Installation Contractor
	Installation of firefighting systems and safety infrastructure in line with NFPA standards	HSE / Safety Contractor
8	Installation of electrical systems, transformer, and standby generator	MEP Contractors
	Finishing works for administrative block, offices, and utility rooms	Building Contractor
9	Testing and dry-run of all systems	Commissioning Engineer
	Recruitment and training of operational staff	HR / Technical Team
	Inspection and compliance checks by FMEnv, NMDPRA, and Fire Service	Regulatory Authorities
10	Final commissioning and system start-up	OEM Engineers / ZAGR Operations Team

Month	Project Phase / Activity	Responsibility
	Customer onboarding and demonstration of gas dispensing	Commercial Unit
11	Commencement of gas dispensing operations at the LPG refilling station	Operations Team
	Final adjustments and troubleshooting	Operations / Maintenance Team
12	Full-scale operations and performance monitoring	ZAGR Management
	Site documentation, regulatory reporting, and project close-out	QA/QC / Documentation Officer

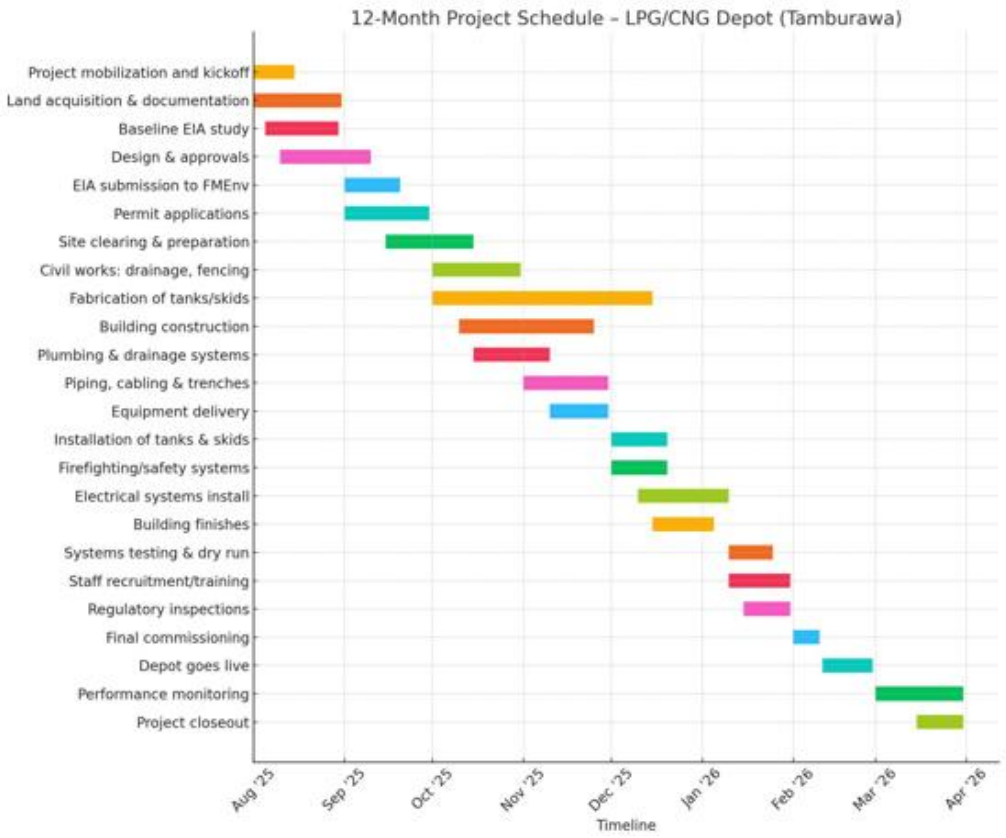


Figure 3.6: Gantt chart for the Project

3.8 PROJECT DESIGN COMPONENTS

The proposed LPG Storage and Refilling Plant is designed with integrated operational, safety, environmental, and support infrastructure to ensure efficient, safe, and environmentally sound operations. The major components of the project design are outlined below.

3.8.1 LPG Storage System

The storage system comprises high-pressure horizontal cylindrical steel tanks fabricated in accordance with recognized industry standards. The tanks are mounted on reinforced concrete foundations and fitted with pressure relief valves, level indicators, temperature gauges, emergency shut-off valves, and anti-corrosion protection systems. The storage area is secured within a fenced enclosure with restricted access.

3.8.2 Gas Compression Unit

The facility includes high-pressure compressor units responsible for regulating and maintaining the required pressure for LPG transfer and refilling. The compression system is automated and integrated with a programmable logic control (PLC) panel for real-time monitoring of pressure, temperature, and flow parameters. Safety interlock systems are installed to ensure automatic shutdown in the event of abnormal operating conditions.

3.8.3 Cylinder Filling and Dispensing Unit

Designated filling bays will be provided for refilling LPG cylinders of various capacities, including 6 kg, 12 kg, 25 kg, and 35 kg. The dispensing system incorporates calibrated electronic filling machines, leak-proof hoses, double nozzles, and automated metering devices to ensure safe and accurate refilling operations.

3.8.4 Truck Loading and Offloading Facilities

The plant design includes dedicated areas for tanker offloading and truck loading operations. These facilities are equipped with high-pressure transfer pipelines, grounding systems to prevent static discharge, wheel stoppers, and spill containment measures to enhance operational safety during product transfer.

3.8.5 Fire Protection and Safety Systems

Comprehensive fire protection infrastructure is incorporated into the project design. This includes fire hydrants, portable fire extinguishers (dry chemical powder and CO_2 types), gas detection and alarm systems, emergency shut-off valves, pressure relief systems, and clearly marked emergency assembly points and escape routes.

3.8.6 Control Room and Administrative Facilities

An administrative building will accommodate office spaces, staff welfare facilities, and a central control room. The control room will house the PLC monitoring system, CCTV surveillance equipment, communication systems, and emergency response coordination tools.

3.8.7 Utilities and Supporting Infrastructure

Supporting infrastructure includes a standby power generator, electrical installations, on-site borehole water supply, stormwater drainage channels, an oil-water separator, paved access roads, perimeter fencing, security posts, and adequate lighting and safety signage throughout the facility.

3.8.8 Environmental Management Features

Environmental protection measures integrated into the design include waste segregation and storage facilities, spill containment structures, landscaped green buffer zones to reduce dust and noise, and proper drainage systems to prevent surface and groundwater contamination

Figure 3.7: Premises of the LPG Station

CHAPTER FOUR

DESCRIPTION OF THE EXISTING CONDITIONS OF THE PROJECT ENVIRONMENT

4.1 INTRODUCTION

This chapter provides a comprehensive overview of the study framework and field methodologies employed for the Environmental Status Assessment of the proposed 200 metric tons Liquefied Petroleum Gas (LPG) Storage and Refilling Plant along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State. It presents the baseline environmental conditions of the project site and its immediate surroundings prior to the commencement of any project activities.

The findings reported in this chapter are based on systematic field investigations, in-situ measurements, and laboratory analyses carried out in accordance with the guidelines of the Federal Ministry of Environment. The baseline survey was conducted during the wet season to capture representative environmental conditions, with particular focus on key physical parameters such as air quality, soil characteristics, surface and groundwater quality, ambient noise levels, and meteorological conditions. Biological components within the project's area of influence were also assessed. The use of standardized sampling protocols and analytical procedures ensured the accuracy, consistency, and reliability of the environmental data generated.

In addition, socio-economic conditions and public health aspects within Bodinga community and neighboring settlements were evaluated through a combination of literature review, administration of structured field checklists, and Focus Group Discussions (FGDs) with community members and key stakeholders. This integrated methodology provides a holistic understanding of the existing environmental and social context, forming the basis for evaluating potential impacts of the proposed LPG facility.

4.2 BASELINE STUDY METHODOLOGY AND CHAIN OF CUSTODY

The Environmental Impact Assessment (EIA) for the proposed 200 metric tons Liquefied Petroleum Gas (LPG) Storage and Refilling Plant opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State was conducted using an integrated and participatory study approach. Baseline ecological and socio-environmental data were collected through a combination of desktop

reviews, structured field investigations, laboratory analyses, interviews, and stakeholder consultations. This approach ensured a comprehensive understanding of existing environmental conditions, incorporating technical assessments alongside inputs from community members, relevant institutions, and key stakeholders.

The primary baseline data collected formed the foundation for identifying and evaluating potential environmental and social impacts associated with the proposed LPG facility. These assessments informed the development of appropriate mitigation measures, culminating in the preparation of a comprehensive Environmental and Social Management Plan (ESMP). Field investigations focused on key environmental components, including ambient air quality, surface and groundwater quality, soil characteristics, vegetation mapping and health status, fauna resources, socio-economic conditions, and human health considerations.

Flora and fauna within the project area were documented through direct observations, auditory detection of animal calls, and indirect indicators such as tracks and remains. These data were analyzed to provide a detailed account of species composition and ecological characteristics. Socio-economic assessments were conducted to capture community perspectives, concerns, and expectations through structured interviews, focus group discussions (FGDs), stakeholder consultations, and the administration of questionnaires to residents of Birnin Kebbi Road and nearby settlements. Field visits also targeted sensitive receptors, including markets, schools, places of worship, and other public facilities within and around the project site.

Primary data collection was carried out during the wet season, providing representative environmental conditions for the site. To supplement these observations, validated secondary data from comparable locations within the Sudan Savannah ecological zone were incorporated. This region is characterized by relatively uniform climatic and ecological conditions, including distinct wet and dry seasons, consistent temperature regimes, similar wind patterns, and comparable soil and vegetation characteristics. During periods of environmental stability, particularly the dry season, key parameters such as air quality, soil properties, and hydrological conditions exhibit minimal spatial variation across the ecological zone.

Hydrological and soil conditions across the project area are relatively stable due to limited surface runoff and low groundwater recharge during the dry season, resulting in minimal variation in pH, electrical conductivity, total dissolved solids, and other basic water and soil quality indicators. In the absence of significant industrial activity or prominent topographical differences, the use of secondary data from analogous sites within the same ecological and climatic context is considered appropriate and reliable for baseline environmental characterization.

From a regulatory and best-practice standpoint, both national EIA guidelines and international standards recognize the use of secondary data for baseline studies in areas with similar ecological, climatic, and anthropogenic characteristics, provided that the data are credible and unaffected by site-specific contamination. Accordingly, the combined application of primary field data and validated secondary information provides a robust and reliable basis for predicting environmental impacts, planning mitigation measures, and supporting sustainable development of the proposed LPG Storage and Refilling Plant at Birnin Kebbi Road, Bodinga LGA.

4.2.1 Methodology Used for the Socio-Economic Study

The methodology adopted for the socio-economic study of the proposed LPG Refilling plant in Birnin Kebbi Road, Bodinga Local Government Area (LGA) of Sokoto State was designed to generate reliable, representative, and community-based data. The primary objective of the study was to establish the demographic, economic, and social baseline conditions within the project's area of influence and to identify potential socio-economic impacts that may arise during the construction and operational phases of the project. The information obtained provides the basis for impact assessment, mitigation planning, and the development of appropriate stakeholder engagement strategies throughout the project life cycle.

The study area was defined to cover Birnin Kebbi Road and surrounding settlements located within an approximate 3-kilometre radius of the proposed LPG project site. These communities were selected based on proximity to the project location and the likelihood of direct or indirect interaction with project activities. The communities share broadly similar socio-economic characteristics, including predominantly agrarian and informal economic livelihoods, limited public infrastructure, and strong social cohesion based on extended family and communal systems.

A stratified random sampling technique was adopted to ensure adequate representation of the study population. Each identified community within the study area was treated as a stratum, and households were randomly selected within each stratum to capture diverse household-level perspectives. Based on local estimates and key informant inputs, the total number of households within the study area was estimated, and a sampling ratio of approximately 10 percent was applied in line with standard socio-economic research practice. This approach ensured that the sample size was sufficient to reflect prevailing socio-economic conditions while remaining manageable for detailed field assessment.

Greater representation was allocated to Birnin Kebbi Road as the immediate host community where the proposed LPG facility is located, while surrounding communities received proportionate allocations based on estimated population size and proximity to the project site. This proportional distribution was

intended to reflect both potential exposure to project impacts and population distribution within the area of influence.

Data collection was carried out using a structured household questionnaire designed to capture both quantitative and qualitative information. Key thematic areas covered included household composition, age and gender structure, educational attainment, religious affiliation, primary and secondary economic activities, income sources, housing characteristics, and access to basic services such as water supply, sanitation, electricity, and healthcare. Additional sections of the questionnaire assessed community awareness of the proposed LPG project, perceptions of potential benefits and risks, expectations regarding employment and infrastructure development, and willingness to participate in ongoing consultations. Open-ended questions were included to allow respondents to freely express concerns, expectations, and suggestions.

Primary data collection was conducted through face-to-face interviews with adult household representatives, preferably household heads or senior members aged 18 years and above. The fieldwork was undertaken by trained enumerators fluent in the local language, under the supervision of field coordinators responsible for quality control and logistical coordination. Enumerators received training on ethical research conduct, including voluntary participation, informed consent, and confidentiality. Responses were recorded manually, and supplementary field notes were taken where clarification or contextual interpretation was required.

To ensure data quality and consistency, completed questionnaires were reviewed daily by field supervisors, and any gaps or unclear responses were addressed promptly through follow-up interactions within the communities. After completion of fieldwork, data were coded and entered into Microsoft Excel before being transferred to statistical software for analysis. Descriptive statistical techniques, including frequency distributions and percentage analysis, were used to summarize and interpret the socio-economic characteristics of the study area.

The study was conducted in accordance with accepted ethical standards. Verbal informed consent was obtained from all respondents prior to participation, and approvals were sought from relevant community leaders before commencement of field activities. Participation was voluntary, no incentives were provided, and all information collected was treated as confidential and used solely for environmental assessment and development planning purposes.

Some limitations were encountered during the study, including the absence of formal population records at the community level, which required reliance on estimates validated through local leaders and key

informants. In addition, seasonal mobility associated with farming and informal economic activities limited access to some adult respondents during the survey period. Despite these constraints, the methodology adopted and the data obtained provide a credible and sufficiently robust socio-economic baseline for assessing potential social impacts and designing appropriate mitigation and management measures for the proposed LPG Refilling plant in Birnin Kebbi Road, Bodinga LGA.

4.2.2 Literature Review

Relevant literature applicable to the project area was reviewed to support the baseline environmental assessment for the proposed LPG refilling plant in Birnin Kebbi Road, Bodinga Local Government Area of Sokoto State. The review covered existing studies, reports, and publications related to air quality, water resources, soil characteristics, noise environment, climatic parameters (temperature, humidity, and rainfall), topography, geology, hydrogeology, ecological conditions, and the socio-economic characteristics of communities within the project area. The purpose of the literature review was to establish a background understanding of the environmental setting, identify ecological attributes of the area, and support the interpretation of field data, particularly with respect to the composition and distribution of flora and fauna and other site-specific environmental features.

4.2.3 Field Survey

Field surveys and sample collection were undertaken to generate primary baseline data for the Environmental Impact Assessment of the proposed LPG project. The field activities were designed to achieve the following objectives:

- Identification of sensitive environmental and social receptors within and around the project site in Birnin Kebbi Road.
- Reconnaissance surveys to gain a general understanding of the physical and environmental characteristics of the project location.
- Identification of ecologically sensitive areas and important species of flora and fauna present within the study area.
- Identification and geo-referencing of environmental sampling locations.
- Assessment of proposed project activities and their potential interactions with environmental components such as soil, water, air, vegetation, and fauna.
- Collection of relevant environmental samples from within and around the project area for laboratory analysis.

4.2.4 Methods of Sample Data Collection

Environmental samples were collected from representative locations within the study area during the field survey period in December 2025. Water and soil samples were collected from selected points around the project site and transported to an accredited laboratory for analysis. The geographic coordinates of all sampling locations were recorded to ensure accuracy and reproducibility.

Ambient air quality and noise level measurements were conducted at four locations within the project area, with an additional control point established outside the zone of direct project influence. Similarly, soil samples were obtained from four locations within the study area and one control location to provide comparative baseline data.

Surface water samples were collected from nearby surface water bodies within the broader Birnin Kebbi Road–Bodinga environment that are representative of local hydrological conditions. Groundwater samples were obtained from functional boreholes located within and around the project area, while municipal water samples were collected where applicable to assess existing water quality conditions.

All collected samples were analyzed at the Sokoto State Ministry of Environment laboratory in Sokoto State. In addition to laboratory sampling, on-site assessments were conducted to evaluate the physical, chemical, geological, topographical, and geophysical characteristics of the project area. These assessments provided essential baseline information for understanding existing environmental conditions and for predicting potential impacts associated with the construction and operation of the proposed LPG refilling station.

Noise Levels

Noise measurements were carried out using a dosimeter at multiple locations and elevations within the study area. A sound level meter with three selectable measurement ranges (30–80 dB, 50–100 dB, and 80–130 dB) was used. After powering on the device, the appropriate range was selected via the range button. The instrument was held approximately 3 meters above ground level, allowing the microphone sensor to capture ambient noise. The noise level readings, expressed in decibels (dB), were displayed on an LCD screen.

Additional detection for noise, vibration, and air parameters was conducted using specialized handheld meters. These devices provided continuous digital readings for the respective parameters. Soil and water samples were collected in properly labeled containers, stored under suitable conditions, and transported to the laboratory for further analysis. Concentrations of metals and inorganic and organic constituents

were determined using colorimetric and titrimetric methods in accordance with the American Public Health Association (APHA) standard procedures.

Air Quality

Air quality monitoring employed a multifunctional handheld smart sensor equipped with electrochemical, infrared, and metal oxide semiconductor (MOS) sensors. Sampling was conducted at various strategic points within the project area during the dry season, with measurements taken at breathing zone height (approximately 1.5 meters above ground level) under prevailing weather conditions.

Parameters and measurement methods included:

- **Particulate Matter (PM_{10} and $PM_{2.5}$):** Measured in micrograms per cubic meter ($\mu g/m^3$) using laser light scattering sensors integrated within the handheld device.
- **Methane (CH_4):** Detected using a methane-specific non-dispersive infrared (NDIR) sensor calibrated for natural gas concentrations.
- **Oxygen (O_2):** Measured as a percentage of volume using an electrochemical sensor to monitor oxygen levels.
- **Carbon Dioxide (CO_2):** Monitored in parts per million (ppm) using an NDIR sensor suitable for ambient outdoor air assessment.
- **Total Volatile Organic Compounds (TVOCs):** Detected in parts per billion (ppb) or milligrams per cubic meter (mg/m^3) using photoionization detectors (PID) or MOS sensors.
- **Formaldehyde (HCHO):** Measured via an electrochemical sensor with detection sensitivity down to 0.01 ppm.
- **Carbon Monoxide (CO):** Measured in ppm using an electrochemical sensor with real-time display and alarm capabilities.
- **Hydrogen Sulphide (H_2S):** Detected at low ppm levels using a sulfur-selective electrochemical sensor.
- **Gamma Radiation:** Where available, ambient radiation was measured using a Geiger-Müller counter, expressed in microsieverts per hour ($\mu Sv/h$).
- **Electromagnetic Fields (EMF):** Measured with internal antennas detecting electric field strength and magnetic flux density in microteslas (μT) or milligauss (mG).
- **Ammonia (NH_3):** Measured using an electrochemical sensor with detection limits typically in ppm.

- **Halogenated Compounds (e.g., chlorine, bromine):** Detected using multi-gas sensor modules sensitive to halogens when available.

At each monitoring point, measurements were recorded for a minimum duration of three minutes, with manual data recording where necessary. Results were evaluated against the Federal Ministry of Environment (FMEnv) Ambient Air Quality Standards, World Health Organization (WHO) Air Quality Guidelines, and Occupational Exposure Limits (OELs) to assess compliance and potential health risks. Data quality was assured through cross-referencing with concurrent meteorological observations including wind speed and direction, relative humidity, and temperature collected using a handheld weather meter.

Water Samples

Surface water samples were collected from nearby drainage channels and seasonal surface runoff pathways within the vicinity of the proposed LPG Refilling Station at Birnin Kebbi Road, to evaluate existing water quality conditions and determine their suitability for domestic use, irrigation, and protection of the surrounding terrestrial and aquatic environment. The sampling locations were selected to represent potential upstream and downstream influence zones relative to the project site, particularly in relation to storm-water discharge and possible accidental spill pathways. Sampling was conducted using a clean plastic bailer at mid-depth locations, avoiding stagnant areas to minimize sediment contamination. The samples were stored in pre-cleaned polyethylene bottles, with some acidified using nitric acid to preserve metal content, and kept refrigerated at 4°C until laboratory analysis. The parameters analyzed included pH, turbidity, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), major ions (sodium, potassium, calcium, magnesium), nitrate, phosphate, chloride, sulfate, coliform bacteria counts, and heavy metals.

Groundwater quality assessment involved sampling from existing boreholes located within a 1-kilometer radius of the project site. Before sample collection, stagnant water was purged by pumping the borehole for 10 to 15 minutes to ensure representative aquifer water. Samples were collected in clean, sterilized bottles, using separate containers for physicochemical and microbiological analyses. All samples were properly preserved, labeled, and transported under cold chain conditions to the laboratory. Analyses covered physical parameters (color, odor, temperature), chemical constituents (pH, hardness, TDS, chloride, sulfate, nitrate), heavy metals, and microbiological indicators including total and fecal coliforms, following the American Public Health Association (APHA, 2017) standard protocols.

Additionally, samples of treated municipal water were collected to evaluate compliance with World Health Organization (WHO) drinking water standards. Tap water sampling followed standard protocols, including flushing the tap for 3–5 minutes prior to collection in sterilized, sealed containers. Analyzed parameters included residual chlorine, electrical conductivity, pH, TDS, major anions and cations, total coliform bacteria, and heavy metals, employing methods such as titrimetry, flame photometry, and spectrophotometry.

Soil Sampling

Soil sampling was carried out to establish baseline physicochemical properties and detect any potential contamination within the topsoil and subsoil layers of the project area. Composite soil samples were collected from multiple locations inside and around the proposed project site at depths of 0–15 cm and 15–30 cm using a stainless-steel auger. At each sampling point, two subsamples were taken in a triangular pattern, combined, and homogenized in sterile plastic containers before labeling. Each composite sample was then analyzed separately for the two depth intervals.

Samples were stored under cool, dark conditions to preserve integrity during transportation to an accredited laboratory. Analytical parameters included soil pH, electrical conductivity (EC), total organic carbon (TOC), nitrate, phosphate, sulfate, and selected heavy metals (lead, cadmium, zinc, iron, copper, chromium). Additionally, cation exchange capacity (CEC) was determined. The analyses employed methods such as atomic absorption spectroscopy (AAS), ultraviolet (UV) spectrophotometry, and standardized soil digestion techniques.

4.2.5 Preservation and Transfer of Samples

The sample preservation techniques adopted for this study followed the Department of Petroleum Resources (DPR) guidelines as outlined in Table 4.1. All samples were stored in appropriate preservation containers and conveyed to the Sokoto State Ministry of Environment Pollution Control Laboratory, where they were kept in freezers maintained at prescribed temperature ranges for subsequent analysis. Samples designated for microbiological examination were stored under refrigerated conditions. Table 4.2 summarizes the analytical methods and laboratory equipment used for the analysis of soil and water samples.

Table 4.1: DPR-Recommended Preservatives for Various Water Quality Constituents Used by the Laboratory

SN	Parameter	Required Volume (ml)	Container	Preservation Method	Maximum Holding Period
1	pH	35	P, G	Cool at 4°C / Detect on site	6 hours
2	Electrical Conductivity	100	P, G	Cool at 4°C	24 hours
3	Colour	50	P, G	Cool at 4°C	24 hours
4	Odour	200	P, G	Cool at 4°C	24 hours
5	Turbidity	100	P, G	Cool at 4°C	7 days
6	Total Dissolved Solids (TDS)	50	P, G	Filter on site, cool at 4°C	24 hours
7	Total Suspended Solids (TSS)	50	P, G	Filter on site	6 months
8	Total Hardness	100	P, G	Cool at 4°C, HNO_3 to pH < 2	7 days
9	Acidity and Alkalinity	100	P, G	Cool at 4°C	24 hours
10	Salinity (as Cl^-)	50	P, G	None required	7 days
11	Chemical Oxygen Demand (COD)	50	P, G	2 ml H_2SO_4 per litre	7 days
12	Biochemical Oxygen Demand (BOD_5)	1000	P, G	Refrigeration at 4°C	6 hours
13	Surfactants (MBAS)	250	P, G	Cool at 4°C	24 hours
14	Dissolved Oxygen (DO)	300	G only	Detect on site	No holding
15	Ammonia	400	P, G	Cool at 4°C, H_2SO_4 to pH < 2	24 hours
16	Oil and Grease	1000	G only	Cool at 4°C, H_2SO_4 or HCl to pH < 2	24 hours
17	Nitrate (NO_3^-)	100	P, G	Cool at 4°C, H_2SO_4 to pH < 2	24 hours
18	Sulphate (SO_4^{2-})	50	P, G	Cool at 4°C	7 days
19	Carbonate (CO_3^{2-}), Free CO_2 and Bicarbonate (HCO_3^-)	–	P, G	None specified	–
20	Cyanides	500	P, G	Cool at 4°C, NaOH to pH 12	24 hours
21	Phosphorus	–	–	40 mg $HgCl_2$ per litre, cool at 4°C	7 days
22	Phenolics	500	G only	Cool at 4°C, H_3PO_4 to pH < 4, 1 g $CuSO_4$ per litre	24 hours
23	Chromium	100	P, G	HNO_3 to pH < 2	–
24	Arsenic	100	P, G	None specified	6 months

SN	Parameter	Required Volume (ml)	Container	Preservation Method	Maximum Holding Period
25	Cadmium	100	P, G	None specified	6 months
26	Cobalt	–	P, G	None specified	6 months
27	Copper	–	P, G	None specified	6 months
28	Iron	–	P, G	None specified	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	None specified	6 months
32	Zinc	100	P, G	None specified	6 months
33	Vanadium	100	P, G	None specified	6 months
34	Calcium	100	P, G	None required	7 days
35	Magnesium	100	P, G	None specified	6 months

Where P = Plastic and G = Glass

Table 4.2: Summary of Analytical Methods and Equipment Used in Laboratory Analysis of Soil and Water Samples

SN	Parameters Determined	Equipment / Analytical Technique
1	pH	JENCO UC Meter 6100
2	Temperature	JENCO UC Meter 6100
3	Electrical Conductivity (µS/cm)	Hanna HI Conductivity Meter
4	Salinity (% or ppt)	Salinometer
5	Dissolved Oxygen (mg/L)	DO Meter / Winkler's Method
6	Transparency (m)	Secchi Disc
7	Grain Size Distribution	Granulometry and Sedimentation Methods
8	Biochemical Oxygen Demand (BOD_5, mg/L)	HACH BOD Trak
9	Ammonium (NH_4^+, mg/L)	Nessler's Reagent Method
10	Nitrate (NO_3^-, mg/L)	Phenol Disulphonic Acid Method
11	Phosphate (PO_4^{3-}, mg/L)	Colorimetric Method using Molybdenum Blue
12	Sulphate (SO_4^{2-}, mg/L)	Turbidometric and Photometric Methods
13	Total Hydrocarbons (THC, mg/L)	Capillary Gas Liquid Chromatography (GLC)
14	Aliphatic and Aromatic Hydrocarbons (mg/L)	Gas Chromatography–Mass Spectrometry (GC–MS)
15	Total Organic Carbon (TOC, %)	Graphite Furnace Method and Gravimetric Analysis
16	Total Nitrogen (N, %)	Graphite Furnace Method and Gravimetric Analysis
17	Total Dissolved Solids (TDS, mg/L)	Gravimetric Method (Drying to Constant Weight)
18	Total Suspended Solids (TSS, mg/L)	Gravimetric Method (Drying to Constant Weight)

SN	Parameters Determined	Equipment / Analytical Technique
19	Heavy Metals (mg/L or ppm)	Atomic Absorption Spectrophotometer (UNICAM 939) after Acid Digestion
20	Soil Moisture Content (%)	Gravimetric Method (Drying to Constant Weight)
21	Soil Permeability	Falling Head Permeability Test
22	Exchangeable Cations (mg/L)	Atomic Absorption Spectrophotometry after Digestion

4.2.6 Sampling Points

The sampling programme was designed to adequately capture all environmental and ecological components specific to the project site. Environmental field investigations and sampling were conducted within a 600 m radius of the project location, while the socioeconomic assessment and surface water sampling covered a broader area of influence extending up to a 3 km radius.

Further details of the sampling approach are provided below. Figure 4.4 illustrates the spatial distribution of sampling locations within the project area for air quality and noise level measurements, which were conducted at the same points, except for water samples that were collected from designated locations. Tables 4.3 present the geographic coordinates of the sampling points together with the corresponding laboratory analytical results.

Table 4.3 sampling coordinates

	Code	Latitude	Longitude	
1	ZAGRAQ/SS1	12.8828	5.1659	2:24pm
2	ZAGRAQ /SS2	12.8835	5.1671	2:44pm
3	ZAGRAQ/SS3	12.8831	5.1684	3:02pm
4	ZAGRAQ/SS4	12.8824	5.1667	3:22pm
5	ZAGRAQ/SS5	12.8839	5.1678	3:43pm

4.3 CLIMATE

The proposed LPG Refilling Station is located along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State. The project area lies within the Sudan Savannah ecological zone of northwestern Nigeria and experiences a hot tropical continental climate characteristic of the region. Climatic data for

this assessment are derived from long-term records provided by the Nigerian Meteorological Agency, representing the 1991–2020 climatological normal period, in accordance with standards of the World Meteorological Organization. These records provide a reliable baseline for understanding seasonal variations and their implications for the construction and operation of the LPG facility.

Temperature

Sokoto is one of the hottest regions in Nigeria, with extreme dry season temperatures and a pronounced harmattan influence. During the months of March to May, daytime temperatures typically range between 40°C and 44°C, occasionally peaking above 45°C. In contrast, mornings during the harmattan season of December and January may experience temperatures as low as 15°C to 18°C, while afternoons remain warm. The mean annual temperature in the area generally falls between 28°C and 32°C. These high temperatures are important for the safe handling and storage of LPG, as elevated heat increases vapour pressure in tanks and cylinders. To mitigate this risk, the facility design will include pressure relief valves, appropriate tank spacing, heat-resistant materials, adequate ventilation, and work-rest protocols for personnel to prevent heat-related occupational hazards.

Humidity

Relative humidity in Sokoto exhibits distinct seasonal variation. During the dry season, humidity levels are low, typically ranging from 10% to 30%, while the wet season, between June and September, sees higher levels of around 60% to 85%. Low humidity conditions increase the potential for static electricity, which poses an ignition risk in areas where LPG is handled. All metallic tanks, pipelines, and equipment will therefore be properly grounded and bonded during construction and operations. Conversely, higher humidity during the wet season can accelerate corrosion of storage tanks, valves, and structural supports. Anti-corrosive coatings, corrosion-resistant materials, and routine inspection and maintenance programs will be implemented to maintain long-term structural integrity.

Rainfall

Rainfall in Sokoto is concentrated in a short wet season from June to September, with total annual precipitation ranging from approximately 600 mm to 800 mm. August typically experiences the highest rainfall intensity. Intense rainfall events can generate surface runoff, soil erosion, and localized flooding, especially on exposed or poorly compacted surfaces. The LPG station design incorporates an efficient drainage system, paved operational areas, and erosion control measures to prevent water accumulation and ensure safe operation throughout the facility's lifecycle.

Wind Speed and Direction

Wind speed and direction in the project area are important factors affecting the dispersion of accidental gas releases. Average wind speeds generally range from 2 to 6 m/s, with dry season winds predominantly from the northeast due to the harmattan, and wet season winds coming from the southwest. These patterns guide the placement of ventilation systems, gas detectors, emergency venting points, and staff shelters to ensure safety, while structural elements such as signage and lighting are designed to withstand occasional gusts.

Atmospheric Pressure

Atmospheric pressure in Sokoto remains relatively stable, varying between 1008 and 1013 hPa. These moderate variations are accounted for in the calibration of pressure-sensitive equipment, safety valves, and dispensing systems to ensure reliable operation.

Visibility

Visibility in the area is highly seasonal; during the harmattan period, dust haze can reduce visibility to less than 1,000 metres, while in the wet season, clarity often exceeds 10,000 metres. The facility design addresses these challenges with adequate lighting, reflective signage, and clearly marked traffic routes to maintain operational safety.

Ultraviolet Radiation and Sunshine Duration

Sokoto experiences high levels of solar radiation and extended sunshine hours, averaging between 3,000 and 3,200 hours annually. Prolonged solar exposure can increase the temperature of tanks, pipelines, and other outdoor equipment. To mitigate these effects, the LPG facility will utilize UV-resistant materials and coatings, provide shaded operational areas where necessary, and incorporate energy-efficient solar-powered systems for auxiliary applications such as lighting, security, and monitoring. These measures ensure the safe operation and longevity of the infrastructure while promoting sustainable energy use.

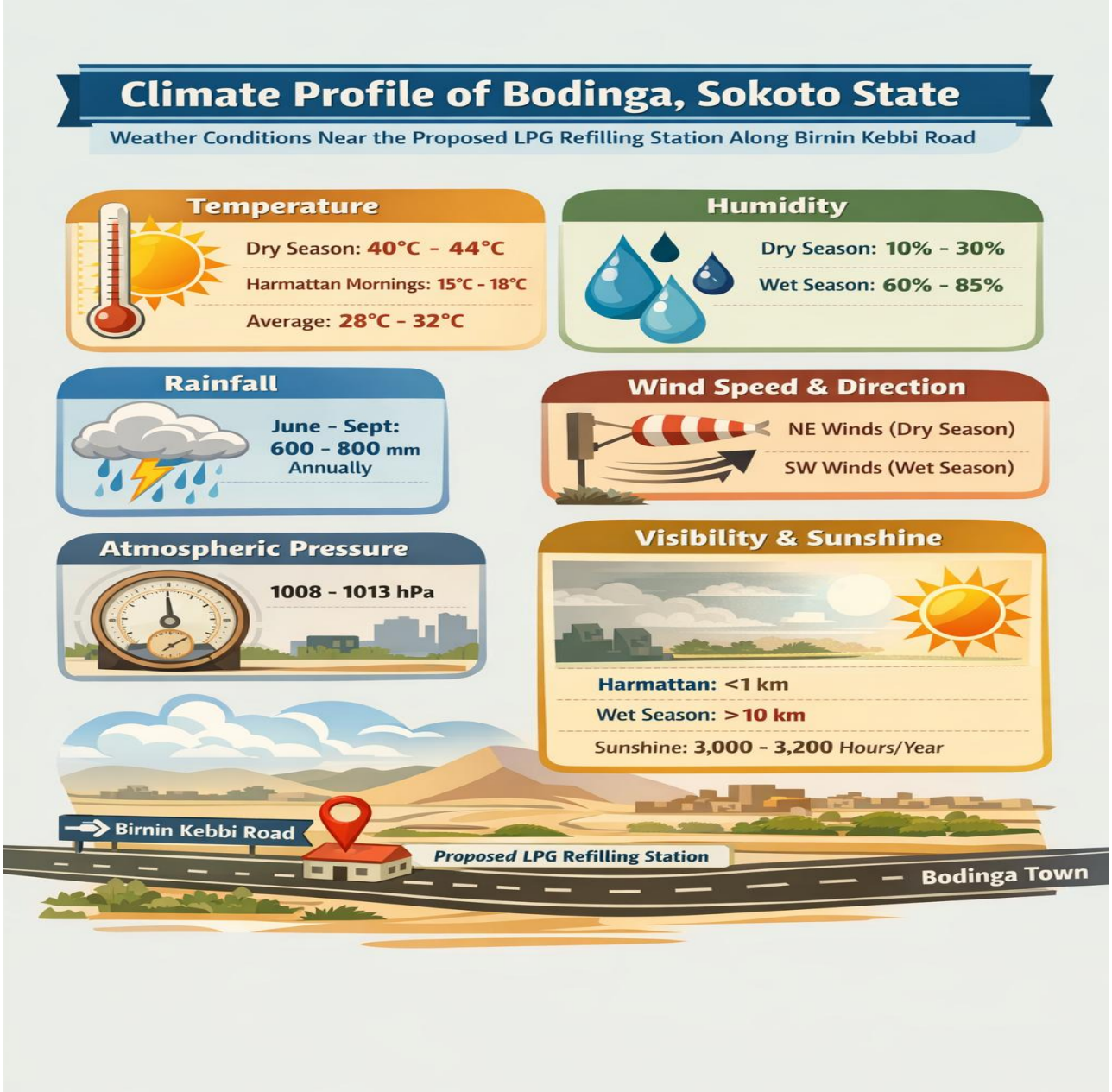


Figure 4.1: Climate Profile of Bodinga LGA

4.4 HYDROLOGY AND TOPOGRAPHY

Hydrology

The proposed Liquefied Petroleum Gas (LPG) refilling station is located along Birnin Kebbi Road within Bodinga Local Government Area of Sokoto State, situated in the semi-arid to sub-humid Sudan Savannah zone of northwestern Nigeria. The hydrology of the area is strongly influenced by seasonal rainfall, ephemeral surface drainage channels, and groundwater recharge controlled by the underlying basement complex geology.

Rainfall in the region is highly seasonal, occurring mainly between May and September, with peak precipitation typically recorded in August. Annual rainfall generally ranges from approximately 700 mm to 1,000 mm, largely as short-duration, high-intensity storm events. These conditions generate rapid surface runoff, particularly over compacted lateritic soils, paved areas, and road networks, increasing the risk of localized flooding and soil erosion where drainage is insufficient.

Surface drainage is dominated by temporary streams and seasonal flow paths that convey runoff during the rainy season. These ephemeral channels are part of the wider Sokoto–Challawa river system within the Hadejia–Jama'are basin. Heavy rainfall events can result in brief but intense flows carrying sediments across low-lying areas. During the dry season, most surface channels remain dry, highlighting the absence of perennial water bodies directly within the project site and underscoring the need for robust stormwater management measures.

Surface water resources are generally limited and primarily associated with seasonal ponds, minor irrigation channels, and agricultural water storage structures. The gently undulating terrain causes runoff to accumulate in natural depressions, which can result in temporary waterlogging if not properly managed. The regional slope directs surface flow predominantly toward the south-west, a critical consideration for the design of site drainage and spill containment measures to prevent off-site migration of pollutants.

Groundwater recharge is relatively low and occurs mainly during the wet season via infiltration of rainfall. Local aquifers are unconfined to semi-confined, hosted within weathered and fractured basement rocks, including granites and gneisses. Boreholes serve as the primary source of groundwater for domestic and agricultural use in surrounding communities. Consequently, the protection of groundwater quality is a priority for the LPG facility to prevent contamination from hydrocarbon leaks, accidental spills, and improper waste management.

The design of the LPG refilling station will therefore incorporate comprehensive hydrological management measures, including perimeter drains, lined channels, and controlled discharge points for stormwater. Spill prevention and containment strategies such as concrete hardstands, bunding, and impermeable surfaces around LPG handling areas will safeguard both surface and groundwater resources.

Topography

The topography of the proposed LPG refilling station site along Birnin Kebbi Road is generally gentle and undulating, with minor variations in elevation. Field observations and topographic data indicate that ground levels range from approximately 467 m to 471 m above mean sea level, resulting in an elevation difference of less than 4 m across the site.

Contour patterns reveal a smooth gradient without steep or abrupt slopes, favorable for construction and natural drainage. Higher ground occurs in the northern and northeastern portions of the site, while the southern and southwestern sections are relatively lower, facilitating natural surface runoff toward the south-west in alignment with regional drainage patterns.

Spot height measurements and field inspections confirm the absence of steep terrain, landslide risk, or significant erosion features. Existing shallow channels and culverts in the surrounding area indicate ongoing management of surface water flow, particularly during the rainy season.

The relatively flat terrain is advantageous for construction and operation of the LPG facility, reducing the need for extensive earthworks and supporting efficient drainage design. Nevertheless, grading, stormwater management, and erosion control measures will be implemented to prevent ponding, soil erosion, and runoff accumulation during periods of intense rainfall

4.6 GEOLOGY AND HYDROGEOLOGY

Geology and Hydrogeology

The proposed LPG refilling station along Birnin Kebbi Road, within Bodinga Local Government Area of Sokoto State, is located on the Precambrian Basement Complex that underlies much of northwestern Nigeria. The local geology is characterized by crystalline igneous and metamorphic rocks, including granites, gneisses, migmatites, and schists. These formations are typically hard and compact, with low primary porosity and limited permeability. Over time, weathering has produced a thin to moderately thick layer of overburden, predominantly composed of lateritic and sandy clay soils, whose depth varies according to topography and the intensity of weathering processes.

In the immediate project area, near-surface soils are mainly reddish-brown laterites underlain by weathered and fractured granite and migmatitic gneiss. These lateritic soils, enriched with iron oxides, generally possess moderate to high bearing capacity, making them suitable for supporting LPG infrastructure, including storage tanks, pump islands, compressors, and internal access pavements. The

underlying weathered and fractured basement rocks introduce secondary permeability, which plays a key role in the occurrence and movement of groundwater in the area.

Hydrogeologically, the site is underlain by a crystalline basement aquifer system in which groundwater is stored and transmitted primarily through fractures, joints, and weathered regolith rather than inter-granular pores. As a result, aquifer distribution is localized and discontinuous, with borehole yields largely dependent on fracture connectivity and the thickness of the weathered layer. In similar basement terrains around Bodinga , groundwater is generally encountered at depths of 15 to 50 metres, with yields sufficient for domestic and small-scale commercial purposes.

The intact basement rocks exhibit very low permeability, limiting widespread infiltration under normal conditions. Groundwater recharge occurs mainly during the rainy season, when rainfall percolates through weathered zones and fracture networks. Surface runoff predominantly follows the regional slope toward the southwest, particularly during periods of intense rainfall.

From both an environmental and engineering perspective, the geological and hydrogeological characteristics of the project area provide several advantages while highlighting key considerations. The competent basement formations offer a stable foundation for heavy infrastructure, minimizing risks of settlement or structural failure. However, the fractured nature of the aquifers means that accidental spills or leaks of LPG condensates, oils, or other hydrocarbons could migrate through subsurface fractures and potentially impact nearby boreholes or shallow wells used by local communities.

To mitigate these risks, all LPG storage tanks, foundations, and pipelines will be designed with reinforced containment systems to prevent subsurface seepage. Concrete hardstands, bund walls, and lined drainage channels will isolate operational areas from the surrounding subsurface environment. Groundwater monitoring points will be established around the facility to detect any potential contamination early, while site grading and stormwater management structures will direct runoff away from identified recharge zones and existing water supply sources, ensuring both operational safety and protection of local water resources.

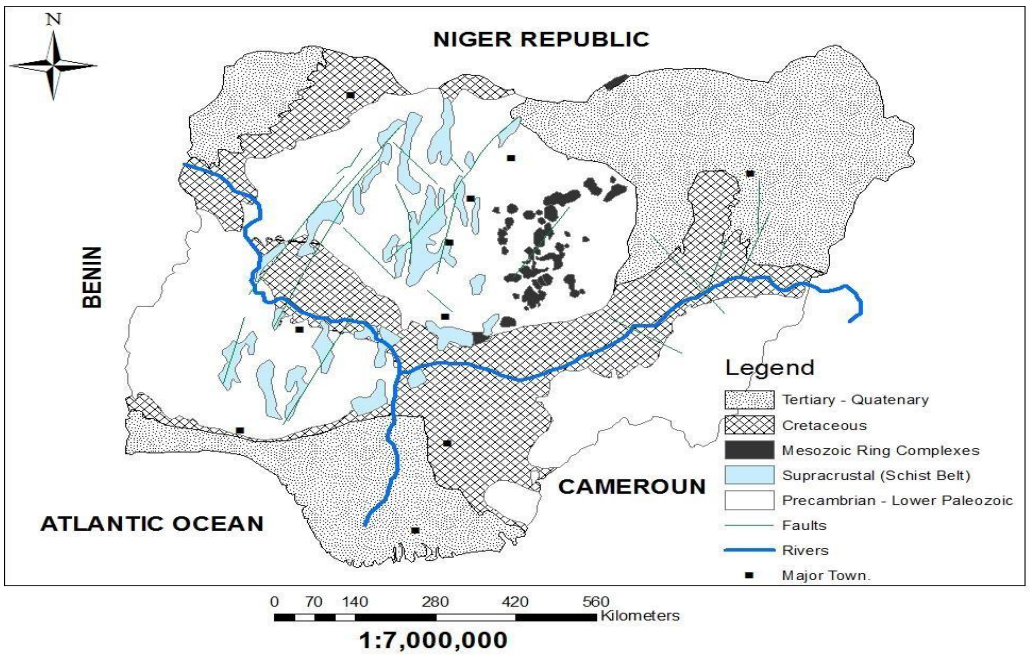


Figure 4.2: Geological Map of Nigeria (NGSA 2010).

4.7 AMBIENT AIR QUALITY ASSESSMENT

Based on field-based air quality monitoring carried out for the proposed LPG facility in Birnin Kebbi Road, Bodinga Local Government Area of Sokoto State, Table 4.4 presents the wet season concentrations of the assessed air quality parameters. The measurements reflect baseline atmospheric conditions within the project area and provide a basis for evaluating potential impacts associated with LPG storage and dispensing activities. The recorded values were compared with relevant Federal Ministry of Environment (FMEnv) regulatory limits and World Health Organization (WHO) guideline standards to determine compliance and to inform appropriate environmental management and mitigation measures for the project.

Table 4.4 Ambient Air Quality and Noise Level around the Project Area

S/N	Parameters	UNIT	POINT 1	POINT 2	POINT 3	POINT 4	CONTROL POINT
1	Latitude	N	12. 5554.8	12.936941	12.9365983	12.936598	12.9409033
2	Longititude	E	5.11118.6	5.1965733	5.19717335	5.19717331	5.1959683
3	Ozone gas (O_3)	ppm	0.001	0.002	0.010	0.003	0.001
4	Phosphine gas (pH_3)	ppm	0.00	0.00	0.00	0.00	0.00
5	Sulphur (IV) Oxide ($S0_3$)	ppm	0.1	0.6	0.0	0.1	0.1
6	Ethene Oxide (	ppm	0	0	0	0	0

	C_2H_4)						
7	Nitrogen (IV) Oxide (NO_2)	ppm	0.2	0.0	0.0	0.3	0.3
8	Hydrogen Chloride (Hcl)	ppm	0.2	0.2	1.3	0.1	1.8
9	Hydrogen Cyanide (HCN)	ppm	0.000	0.000	0.000	0.000	0.000
10	Chlorine Gas (Cl_2)	ppm	0.1	0.1	0.1	0.1	0.0
11	Ammonia Gas (NH_3)	ppm	0	0	0	0	2
12	Carbon (II) Oxide (CO)	ppm	1	3	1	1	6
13	Carbon (iv) Oxide (CO_2)	ppm	407	437	408	431	460
14	EX	ppm	0	0	0	0	0
15	$PM_{2.5}$	µs/cm	24	20	22	27	29
16	PM_{10}	µs/cm	31	26	28	35	37
17	$PM_{1.0}$	µs/cm	8	5	3	6	8
18	Relative humidity	%	22	22	23	23	22
19	Temperautre	^0C	31.6	32.0	31.8	32.0	31.7
20	Wind Speed	m/s	1.3	0.7	0.0	0.4	1.5
21	HCOH	mg/m^3	0.008	0.009	0.006	0.007	0.007
22	TVOC	mg/m^3	0.015	0.015	0.013	0.013	0.011
23	Hydrogen Sulphide (H_2S)	ppm	0.000	0.000	0.000	0.000	0.000
24	Sound Level	dB	53.5	51.5	51.4	45.9	59.8
25	Methane gas (CH_4)	ppm	0	0	0	0	0
26	A Q I	-	Excellent	Excellent	Excellent	Excellent	Excellent

Discussion of Ambient Air Quality and Noise Results

Temperature (°C)

Ambient temperature across the monitoring locations ranged from **31.6°C to 32.0°C**, with an average of approximately **31.8°C**. These values are typical of the semi-arid climatic conditions of Sokoto State and fall within normal environmental limits. While not environmentally hazardous, elevated temperatures are operationally significant for LPG facilities due to their influence on vapour pressure within storage tanks and cylinders. Appropriate tank design, ventilation, and pressure-relief systems are therefore essential.

Relative Humidity (%)

Relative humidity values ranged from **22% to 23%**, indicating dry atmospheric conditions characteristic of the Sudan Savannah region. These values are environmentally acceptable; however, low humidity conditions may enhance electrostatic charge buildup. Proper grounding and bonding of metallic components will therefore be required during LPG handling and operations.

Ozone (O_3, ppm)

Ozone concentrations ranged from **0.001 to 0.010 ppm**, which are very low and well below recommended ambient air quality limits. This indicates minimal photochemical activity and confirms low atmospheric reactivity within the project area.

Sulphur Oxides (SO_x, ppm)

Sulphur oxide concentrations ranged from **0.0 to 0.6 ppm** across the sampling points. While most locations recorded low values, the slightly elevated value at one point may be attributed to minor combustion sources such as vehicular emissions. Overall, the levels do not indicate significant sulphur-related pollution.

Nitrogen Dioxide (NO_2, ppm)

NO_2 concentrations ranged from **0.0 to 0.3 ppm**, with slightly higher values observed at Points 4 and the control location. These concentrations are low and likely associated with vehicular movement along Birnin Kebbi Road. All values remain within acceptable ambient limits.

Carbon Monoxide (CO, ppm)

CO concentrations ranged from **1 to 6 ppm**, with the control point recording the highest value. These levels are within permissible limits and reflect minor contributions from incomplete combustion sources such as vehicle exhausts. No significant CO pollution was observed.

Carbon Dioxide (CO_2, ppm)

CO_2 levels ranged from **407 to 437 ppm** at project locations, while the control point recorded **460 ppm**. These values are consistent with normal atmospheric background concentrations and indicate good air mixing with no evidence of localized accumulation.

Particulate Matter ($PM_{2.5}$, PM_{10}, $PM_{1.0}$ µg/m³)

$PM_{2.5}$ concentrations ranged from **20 to 27 µg/m³**, while PM_{10} ranged from **26 to 35 µg/m³** across the project area. The control point recorded slightly higher values ($PM_{2.5}$: 29 µg/m³; PM_{10}: 37 µg/m³), likely due to roadside dust and vehicular activities. $PM_{1.0}$ ranged from **3 to 8 µg/m³**. These values are within

acceptable limits but reflect typical dry-season dust conditions in Sokoto. Dust suppression measures will be required during construction.

Total Volatile Organic Compounds (TVOC, mg/m³)

TVOC concentrations ranged from **0.011 to 0.015 mg/m³**, indicating very low levels of volatile organic pollutants. This suggests minimal influence from hydrocarbon or industrial sources and establishes a clean baseline for future monitoring.

Formaldehyde (HCOH, mg/m³)

Formaldehyde concentrations ranged from **0.006 to 0.009 mg/m³**, which are low and within acceptable environmental exposure limits. These values indicate negligible indoor or outdoor emission sources within the project area.

Chlorine (Cl_2) and Hydrogen Chloride (HCl, ppm)

Chlorine concentrations ranged from **0.0 to 0.1 ppm**, while hydrogen chloride ranged from **0.1 to 1.8 ppm**, with the highest value recorded at the control point. Although detectable, these concentrations do not indicate persistent industrial pollution and may be attributed to localized environmental factors. Continued monitoring is recommended during project operation.

Hydrogen Sulphide (H_2S), Hydrogen Cyanide (HCN), Phosphine (PH_3), Methane (CH_4), Ethene Oxide (C_2H_4), and EX

These gases were recorded at **0.000 ppm across all sampling points**, indicating the absence of hazardous, toxic, or combustible gas emissions under baseline conditions.

Ammonia (NH_3, ppm)

Ammonia was not detected at the project locations but recorded **2 ppm at the control point**, likely due to localized organic or waste-related sources. The absence of ammonia within the project area indicates minimal biological or waste decomposition influence.

Wind Speed (m/s)

Wind speeds ranged from **0.0 to 1.5 m/s**, with generally calm conditions observed during sampling. Low wind speeds may limit pollutant dispersion; therefore, the facility design will incorporate adequate ventilation and safe dispersion systems.

Noise Levels (dB)

Ambient noise levels ranged from **45.9 to 53.5 dB** across the project area, while the control point recorded **59.8 dB**. These values fall within acceptable limits for mixed residential and commercial environments. Slightly elevated noise levels at the control point may be attributed to traffic activities along Birnin Kebbi Road.

Air Quality Index (AQI)

The Air Quality Index (AQI) was rated **"Excellent"** across all monitoring points, confirming that the ambient air quality within the project area is suitable for the proposed LPG development.

Plate 4.1: Air Quality Measurement of the Project Site

4.8 SOIL STUDY

Soil sampling within the study area was conducted at two depth intervals, namely the surface to 15 cm and 15–30 cm below ground level, using a soil auger. Four soil sampling points were randomly selected across the project area, along with a designated control location, to adequately represent the prevailing soil zones within the site. At each sampling point, composite soil samples were obtained to ensure representative and reliable laboratory analysis. A uniform cross-section soil auger was used throughout the exercise to collect undisturbed and reproducible soil samples.

Prior to sampling, surface litter and undecomposed organic materials were carefully removed to prevent contamination of the soil samples. The collected samples were placed in properly cleaned, clearly labeled sample containers, appropriately preserved, and transported to the laboratory in accordance with established standard procedures. All sampling, preservation, and handling processes followed relevant guidelines and protocols as prescribed by ASTM, the Federal Ministry of Environment (FMEnv), and the American Public Health Association (APHA).

Table 4.5: Soil Quality Result around the Project Area

S/N	Parameters	UNIT	SS 1	SS 2	SS 3	SS 4	SS CONTROL
1	Latitude	N	12.9364251	12.92287714	12.975361	12.9685121	12.9774556
2	Longitude	E	5.197822	5.196342	5.194362	5.193483	5.19352
a)	**Physical Test**						
3	Colour	TCU	Dark Brownish	Ash	Ash	Pale Ash	Brownish
4	pH	-	7.73	8.68	8.34	8.88	7.90
5	Temperature	^0C	32.7	33.5	32.9	31.7	33.4
6	Electrical Conductivity	µs/cm	1150	879	1006	964	725
b)	**Exchangeable Cation**						
7	Calcium (Ca^{2+})	mg/kg	2.57	3.40	3.05	2.99	0.75
8	Magnesium (Mg^{2+})	mg/kg	1.44	0.92	0.96	1.52	2.98
9	Sodium (Na^{+})	mg/kg	2	9	4	4	4
10	Potassium (K^{+})	mg/kg	0.9	2.4	1.4	1.7	2.3
11	Ammonium (NH_4)	mg/kg	1.005	0.999	1.527	2.754	0.115
c)	**Exchangeable Anion**						
12	Sulphate (SO_4^{2+})	mg/kg	47	52	38	55	13
13	Phosphate (PO_4^{2-})	mg/kg	0.92	1.80	0.75	1.09	0.08
14	Nitrate (NO_3^{2-})	mg/kg	16.7	22.8	11.4	10.0	4.8
15	Nitrate (NO_3^{2-})	mg/kg	0.0	0.0	0.0	0.1	1.7
16	Chloride (CL^{-})	mg/kg	0.1	0.0	0.0	0.6	0.3
e)	**Heavy Metals**						
17	Chromium (Cr^{3+})	mg/kg	0.00	0.00	0.00	0.00	0.02
18	Zinc (Zn^{2+})	mg/kg	1. 430	1.256	0.940	1.344	0.532
19	Mercury (Hg^{+})	mg/kg	0.000	0.000	0.000	0.000	0.000
20	Lead (pb^{2+})	mg/kg	0.000	0.000	0.000	0.000	0.000
21	Cupper (Cu^{2+})	mg/kg	0.17	0.25	0.14	0.05	0.00
22	Iron (Fe^{2+})	mg/kg	0.966	1.205	1.006	0.200	0.105
23	Manganese (Mn^{2+})	mg/kg	1.0801	0.5321	0.0042	0.0532	0.0036
24	Cobalt (CO^{2+})	mg/kg	0.010	0.000	0.020	0.004	0.002
f)	**Soil Characteristics**						
25	Sandy	%	9	14	27	22	35
26	Loamy	%	82	74	69	73	49
27	Silt	%	5	11	4	3	10
28	Clay	%	4	1	0	2	6
29	Porosity	mm	0.5	0.9	1.0	1.1	0.6
30	Permeability	cm/hr	7.2	8.1	11.7	14.6	7.4
g)	**Organic**						
31	Oil and grease	Mg/l	0	0	0	0	0
32	Phenols	Mg/l	0.000	0.000	0.000	0.000	0.000
33	B Tex	Mg/l	0	0	0	0	0

h)	**Microbiological Test**						
34	E. Coli	Cfu/ml	30	25	9	27	14
35	Fungal	Cfu/ml	56	17	2	54	6

Discussion

A) Physical Parameters

Colour

Soil colour across the project area varied from **dark brownish (SS1)** to **ash (SS2 and SS3)**, **pale ash (SS4)**, and **brownish at the control point**. These variations are typical of soils within the Sudan Savannah ecological zone and are generally influenced by differences in organic matter content, mineral composition, and drainage conditions rather than anthropogenic contamination.

pH

Soil pH values ranged from **7.73 (SS1) to 8.88 (SS4)**, with the control point recording **7.90**. These values indicate **slightly alkaline soil conditions**, which are common in semi-arid environments such as Sokoto State. The relatively uniform distribution suggests that the soil chemistry is largely controlled by natural factors, with no evidence of site-specific contamination.

Temperature (°C)

Measured soil temperatures ranged from **31.7°C (SS4) to 33.5°C (SS2)**, while the control recorded **33.4°C**. These values reflect prevailing ambient climatic conditions and do not indicate any abnormal thermal influence. The results are consistent with typical surface soil temperatures in the region.

Electrical Conductivity (EC)

Electrical conductivity values ranged from **725 µS/cm (Control) to 1150 µS/cm (SS1)**. The relatively higher values at SS1 and SS3 suggest a moderate presence of dissolved salts, possibly due to natural soil mineralization or evaporation effects. However, the values do not indicate problematic salinity levels.

B) Exchangeable Cations

Calcium (Ca^{2+})

Calcium concentrations ranged from **0.75 mg/kg (Control) to 3.40 mg/kg (SS2)**. The relatively higher values at SS2 and SS3 indicate natural soil enrichment and contribute to soil structure stability and fertility.

Magnesium (Mg^{2+})

Magnesium values ranged from **0.92 mg/kg (SS2) to 2.98 mg/kg (Control)**. The higher concentration at the control point suggests that magnesium levels are largely influenced by natural geochemical conditions rather than project-related activities.

Sodium (Na^+)

Sodium concentrations ranged from **2 mg/kg (SS1) to 9 mg/kg (SS2)**, with the control recording **4 mg/kg**. These values are relatively low and do not indicate any risk of soil sodicity or salinity issues.

Potassium (K^+)

Potassium levels ranged from **0.9 mg/kg (SS1) to 2.4 mg/kg (SS2)**, with the control point at **2.3 mg/kg**. The values reflect normal soil fertility conditions with no evidence of enrichment.

Ammonium (NH_4^+)

Ammonium concentrations ranged from **0.999 mg/kg (SS2) to 2.754 mg/kg (SS4)**, while the control recorded **0.115 mg/kg**. The elevated value at SS4 may indicate localized organic decomposition or nitrogen cycling processes.

C) Exchangeable Anions

Sulphate (SO_4^{2-})

Sulphate concentrations ranged from **38 mg/kg (SS3) to 55 mg/kg (SS4)**, with the control recording **13 mg/kg**. The higher values at project points suggest natural soil mineral composition and possible accumulation due to evaporation.

Phosphate (PO_4^{3-})

Phosphate levels ranged from **0.75 mg/kg (SS3) to 1.80 mg/kg (SS2)**, while the control recorded **0.08 mg/kg**. These values indicate moderate nutrient availability, likely influenced by natural soil fertility conditions.

Nitrate (NO_3^-)

Nitrate concentrations ranged from **10.0 mg/kg (SS4) to 22.8 mg/kg (SS2)**, with the control recording **4.8 mg/kg**. These values suggest moderate nitrogen presence, possibly linked to natural processes and minor anthropogenic inputs such as agricultural activities.

Nitrite (NO_2^-)

Nitrite concentrations were generally low, ranging from **0.0 mg/kg (SS1–SS3) to 0.1 mg/kg (SS4)**, while the control recorded **1.7 mg/kg**. These values indicate minimal recent nitrogen transformation or pollution.

Chloride (Cl^-)

Chloride concentrations ranged from **0.0 mg/kg (SS2 and SS3) to 0.6 mg/kg (SS4)**, with the control at **0.3 mg/kg**. These low values indicate no evidence of salinity intrusion or contamination.

D) Heavy Metals

Chromium (Cr^{3+})

Chromium was not detected at project sites (0.00 mg/kg) but recorded **0.02 mg/kg at the control point**, indicating negligible background presence.

Zinc (Zn^{2+})

Zinc concentrations ranged from **0.940 mg/kg (SS3) to 1.430 mg/kg (SS1)**, with the control at **0.532 mg/kg**. These values are within natural background limits and environmentally acceptable.

Mercury (Hg^{2+}) and Lead (Pb^{2+})

Both Mercury and Lead were **not detected (0.000 mg/kg)** across all sampling points, confirming the absence of contamination from these toxic heavy metals.

Copper (Cu^{2+})

Copper concentrations ranged from **0.05 mg/kg (SS4) to 0.25 mg/kg (SS2)**, with no detectable level at the control point. These values are low and within acceptable environmental limits.

Iron (Fe^{2+})

Iron levels ranged from **0.200 mg/kg (SS4) to 1.205 mg/kg (SS2)**, with the control at **0.105 mg/kg**. These values reflect typical ferruginous soil characteristics of the region.

Manganese (Mn^{2+})

Manganese concentrations ranged from **0.0042 mg/kg (SS3) to 1.0801 mg/kg (SS1)**, indicating natural variability in soil mineral composition.

Cobalt (Co^{2+})

Cobalt levels ranged from **0.000 mg/kg (SS2) to 0.020 mg/kg (SS3)**, with the control at **0.002 mg/kg**. These values are low and reflect natural geochemical occurrence.

E) Soil Characteristics

The soils are predominantly **loamy**, ranging from **49% (Control) to 82% (SS1)**. Sandy fractions ranged from **9% (SS1) to 35% (Control)**, while silt ranged from **3% to 11%**, and clay ranged from **0% to 6%**.

Permeability values ranged from **7.2 to 14.6 cm/hr**, indicating **moderate to high infiltration capacity**, while porosity ranged from **0.5 to 1.1 mm**, suggesting adequate aeration. These characteristics are suitable for construction but require proper containment measures to prevent subsurface migration of contaminants.

F) Organic Parameters

Oil and Grease, BTEX, and Phenols

Oil and grease, BTEX, and phenols were **not detected (0 mg/l or 0.000 mg/l)** across all sampling points, confirming the absence of hydrocarbon contamination at baseline conditions.

G) Microbiological Parameters

E. coli

E. coli counts ranged from **9 cfu/ml (SS3) to 30 cfu/ml (SS1)**, with the control recording **14 cfu/ml**. These values indicate normal microbial activity likely associated with natural soil processes and possible human or animal influence.

Fungal Count

Fungal counts ranged from **2 cfu/ml (SS3) to 56 cfu/ml (SS1)**, compared to **6 cfu/ml at the control point**. The higher counts at SS1 and SS4 suggest localized organic matter influence. Overall, the values reflect typical microbial variability in tropical soils.

Plate 4.2: Soil Measurement of the Project Site

4.9 WATER QUALITY

Surface water quality is influenced by a range of physical factors, including topography, land use and cover, soil characteristics, mineral composition, and groundwater interactions, all of which are closely linked to the underlying geological setting. In addition, river flow regimes are strongly controlled by climatic elements such as the timing, intensity, and volume of rainfall, as well as temperature and other factors that affect evaporation rates.

In a similar manner, groundwater quality varies spatially depending on the nature of the subsoil and the types of rock formations through which the water moves. Daly (1994) noted that groundwater occurring in areas underlain by limestone and limestone-rich subsoils is typically hard, with elevated concentrations of calcium, magnesium, and bicarbonates. In contrast, softer groundwater is more common in regions dominated by volcanic rocks or sandstone formations.

Against this background, any assessment of potential impacts from human activities such as the proposed LPG project in Birnin Kebbi Road, Bodinga Local Government Area must begin with an understanding of the natural or baseline water quality conditions. Groundwater is often perceived as clean and safe for consumption because it undergoes natural filtration as it percolates through soil and rock layers, a process not available to surface water. Nevertheless, this natural filtration does not guarantee absolute purity, as groundwater quality can be affected by inherent geological conditions as well as contamination

arising from anthropogenic activities. The groundwater quality results obtained for the project area are presented in Table 4.6.

Table 4.6: Water Quality Result around the Project Area

S/N	Parameters	UNIT	BH1	Control	FMENT Limit
1.	Latitude	N	12.9496321	12.9505321	-
2.	Longitude	E	$5^0$196663	5.194436	-
a)	**Physiochemical Test**				
3.	Colour	TCU	Clear	Clear	Clear
4.	Odour	-	Odourless	Odourless	Unobjectionable
5.	Taste	-	Tasteless	Tasteless	Unobjectionable
6.	pH	-	8.43	8.08	6.5 – 8.5
7.	Electrical Conductivity	µs/cm	927	732	1000
8.	Total Dissolve solid	mg/L	67	29	500
9.	Total Suspended Solid	mg/L	1	1	20
10.	Turbidity	ntu	2	0	50
11.	Dissolve oxygen	mg/L	4.1	4.4	2 – 8
12.	B.O.D	mg/L	2.5	2.0	NS
13.	Salinity	mg/L	3.6	2.9	<1000
14.	Alkalinity	mg/L	1.01	1.27	30 – 400
b)	**Chemical Test**				
15.	C.O.D	mg/L	0	0	30
16.	Potassium (K^+)	mg/L	1.6	0.5	20
17.	Total Hardness	mg/L	149	78	150
18.	Calcium (Ca^{2+})	mg/L	56	46	200
19.	Magnesium (mg^{2+})	mg/L	33	18	20
20.	Nitrate (NO_3^{2-})	mg/L	1.7	0.5	50
21.	Nitrite (NO_2^-)	mg/L	0.0	0.0	0.2
22.	Chloride (Cl^-)	mg/L	1.9	1.2	150
23.	Phosphate (PO_4^{2-})	mg/L	45	3.8	NS
24.	Sulphate (SO_4^{2-})	mg/L	13	29	100
c)	**Heavy Metal**				
25.	Cupper (Cu^{2+})	mg/L	0.069	0.113	2.0
26.	Cobalt (CO^{2+})	mg/L	0.10	0.00	0.2
27.	Chromium (Cr^{3+})	mg/L	0.00	0.00	0.005
28.	Nickel (NI^{2+})	mg/L	0.0186	0.0215	0.03
29.	Mercury (Hg^+)	mg/L	0.000	0.000	0.0001
30.	Lead (Pb^{2+})	mg/L	0.000	0.000	0.001
31.	Zinc (Zn^{2+})	mg/L	0.03	0.03	3.0
32.	Iron (Fe^{2+})	mg/L	0.03	0.02	1.0
d)	**Organics**				
33.	Oil and Grease	mg/L	0	0	10
34.	Phenols	mg/L	0.000	0.000	0.05
35.	BTEX		0	0	Nil
e)	**Microbiological Test**				
36.	E. Oil	Cfu/ml	0	0	0
37.	Total Coliform	Cfu/ml	2	4	10

Discussion

A) Physical Parameters

Colour, Odour and Taste:

Groundwater samples from **BH1 and the control location were clear, odourless, and tasteless**, complying with the **FMEnv standard for potable water quality**. These characteristics indicate that the groundwater is free from visible contamination, hydrocarbon influence, or sewage intrusion. The baseline condition reflects good groundwater quality within the project area.

pH:

The pH values recorded were **8.43 (BH1)** and **8.08 (Control)**, both within the FMEnv permissible range of **6.5–8.5**. This indicates **slightly alkaline conditions**, which are typical of groundwater in semi-arid regions like Sokoto State. The values reflect natural geochemical processes with no indication of contamination.

Electrical Conductivity (EC):

Electrical conductivity values were **927 µS/cm (BH1)** and **732 µS/cm (Control)**, both below the FMEnv limit of **1000 µS/cm**. These values indicate moderate ionic content and acceptable levels of dissolved minerals in the groundwater.

Total Dissolved Solids (TDS) and Total Suspended Solids (TSS):

TDS values were **67 mg/L (BH1)** and **29 mg/L (Control)**, while TSS was **1 mg/L** at both locations. These values are significantly below FMEnv limits (**500 mg/L for TDS and 20 mg/L for TSS**), indicating low levels of dissolved and suspended materials and confirming good water quality.

Turbidity:

Turbidity values were **2 NTU (BH1)** and **0 NTU (Control)**, both well below the FMEnv limit of **50 NTU**. This confirms that the groundwater is clear with negligible particulate matter.

Dissolved Oxygen (DO):

DO concentrations were **4.1 mg/L (BH1)** and **4.4 mg/L (Control)**, falling within the acceptable FMEnv range of **2–8 mg/L**. These values indicate well-oxygenated groundwater conditions and absence of organic pollution.

Biochemical Oxygen Demand (BOD):

BOD values were **2.5 mg/L (BH1)** and **2.0 mg/L (Control)**. These low values indicate minimal presence of biodegradable organic matter, confirming that the groundwater is not impacted by organic waste or pollution sources.

Salinity and Alkalinity:

Salinity values were **3.6 mg/L (BH1)** and **2.9 mg/L (Control)**, which are extremely low and indicate freshwater conditions.
Alkalinity values were **1.01 mg/L (BH1)** and **1.27 mg/L (Control)**, below the FMEnv recommended range (**30–400 mg/L**). While this suggests low buffering capacity, it does not indicate contamination.

B) Chemical Parameters

Chemical Oxygen Demand (COD):

COD was **0 mg/L** at both locations, indicating the absence of oxidizable chemical pollutants and confirming no industrial contamination.

Total Hardness, Calcium, and Magnesium:

Total hardness values were **149 mg/L (BH1)** and **78 mg/L (Control)**, with BH1 approaching the FMEnv limit (**150 mg/L**). This indicates moderately hard water at BH1.
Calcium concentrations (**56 mg/L and 46 mg/L**) are well below the limit (**200 mg/L**), while magnesium at **33 mg/L (BH1)** slightly exceeds the FMEnv guideline (**20 mg/L**). This elevated magnesium level is likely due to natural geological sources rather than contamination.

Nitrate and Nitrite:

Nitrate concentrations were **1.7 mg/L (BH1)** and **0.5 mg/L (Control)**, well below the FMEnv limit of **50 mg/L**, indicating low nutrient levels.
Nitrite was **0.0 mg/L** at both locations, confirming absence of recent nitrogenous pollution.

Chloride and Sulphate:

Chloride concentrations (**1.9 mg/L and 1.2 mg/L**) and sulphate levels (**13 mg/L and 29 mg/L**) are far below FMEnv limits (**150 mg/L and 100 mg/L respectively**). These values indicate no saline intrusion or chemical contamination.

Phosphate:

Phosphate concentration at **BH1 (45 mg/L)** is significantly higher than the control (**3.8 mg/L**) and may be considered elevated. Since LPG operations do not involve phosphate compounds, this may be attributed to **agricultural activities, detergent residues, or organic waste infiltration** rather than project-related influence.

Potassium:

Potassium concentrations were **1.6 mg/L (BH1)** and **0.5 mg/L (Control)**, both well below the FMEnv limit (**20 mg/L**), indicating low chemical enrichment.

C) Heavy Metals

Heavy metals including **copper, cobalt, chromium, nickel, mercury, lead, zinc, and iron** were either **not detected or present at concentrations well below FMEnv permissible limits**.

Copper (0.069–0.113 mg/L) and **Cobalt (0.00–0.10 mg/L)** are within safe limits.

Chromium, Mercury, and Lead were not detected, confirming absence of toxic metal contamination.

Nickel (0.0186–0.0215 mg/L) remains below the limit (**0.03 mg/L**).

Zinc and Iron concentrations are also low and within acceptable limits.

Overall, there is **no evidence of heavy metal pollution** in the groundwater.

D) Organic Compounds

Oil & Grease and BTEX:

Oil and grease and BTEX compounds were **not detected (0 mg/L)** in both samples. This is particularly important for the proposed LPG project, as it confirms the **absence of hydrocarbon contamination** and establishes a clean baseline.

Phenols:

Phenols were **not detected**, indicating no industrial organic contamination.

E) Microbiological Parameters

E. coli:

E. coli was **absent (0 cfu/ml)** in both BH1 and control samples, meeting FMEnv standards and indicating no faecal contamination.

Total Coliform:

Total coliform counts were **2 cfu/ml (BH1)** and **4 cfu/ml (Control)**, both within the FMEnv limit of **10 cfu/ml**. These values indicate minimal microbial presence and acceptable sanitary conditions.

Implications for the Proposed LPG Project

Overall, groundwater quality at **BH1 is within acceptable FMEnv limits for most parameters**, indicating good baseline environmental conditions. The only notable observation is the **elevated phosphate concentration and slightly high magnesium level**, which are likely due to natural processes or surrounding anthropogenic activities such as agriculture rather than LPG-related operations.

To ensure continued protection of groundwater resources, the project should implement the following measures:

- Installation of **secondary containment systems** for LPG storage tanks
- Use of **impermeable surfaces and bunded areas** within operational zones
- Development of an **efficient stormwater drainage system**
- Implementation of **routine groundwater monitoring** during construction and operation
- These measures will help maintain groundwater integrity and prevent potential contamination throughout the project lifecycle.

4.10 BIODIVERSITY

A biodiversity assessment was conducted within the proposed LPG project area at Birnin Kebbi Road, Bodinga Local Government Area, Sokoto State, to evaluate the existing vegetation and faunal composition, as well as the ecological interactions between plant and animal species. This assessment provides baseline ecological information required to identify potential impacts of the proposed LPG facility and to guide appropriate mitigation measures.

4.10.1 Vegetation

Nigeria is located within the tropical climate belt and experiences distinct seasonal changes in rainfall, temperature, and humidity. These climatic elements significantly influence the country's vegetation patterns and distribution. In particular, the quantity and seasonal distribution of rainfall largely determine the types of plant species that can survive and flourish in different parts of the country.

In the Birnin Kebbi Road area, vegetation reflects the semi-arid environmental conditions typical of northern Nigeria, where rainfall occurs seasonally and humidity varies between the dry and wet periods. Consequently, the dominant vegetation consists mainly of savannah species adapted to low moisture availability and extended dry seasons. These climatic conditions shape the structure, diversity, and overall biomass of plant communities within the project area.

Vegetation within and around the proposed LPG project site is mainly characterized by scattered grasses, shrubs, and few drought-resistant trees, many of which have been modified by human activities such as farming, grazing, fuelwood collection, and settlement development. The existing plant cover therefore represents a disturbed ecosystem rather than a pristine natural habitat.

Given the nature of the proposed LPG project, which has a relatively small land footprint, impacts on vegetation are expected to be localized and manageable, provided that site clearing is minimized and appropriate rehabilitation measures are implemented after construction.

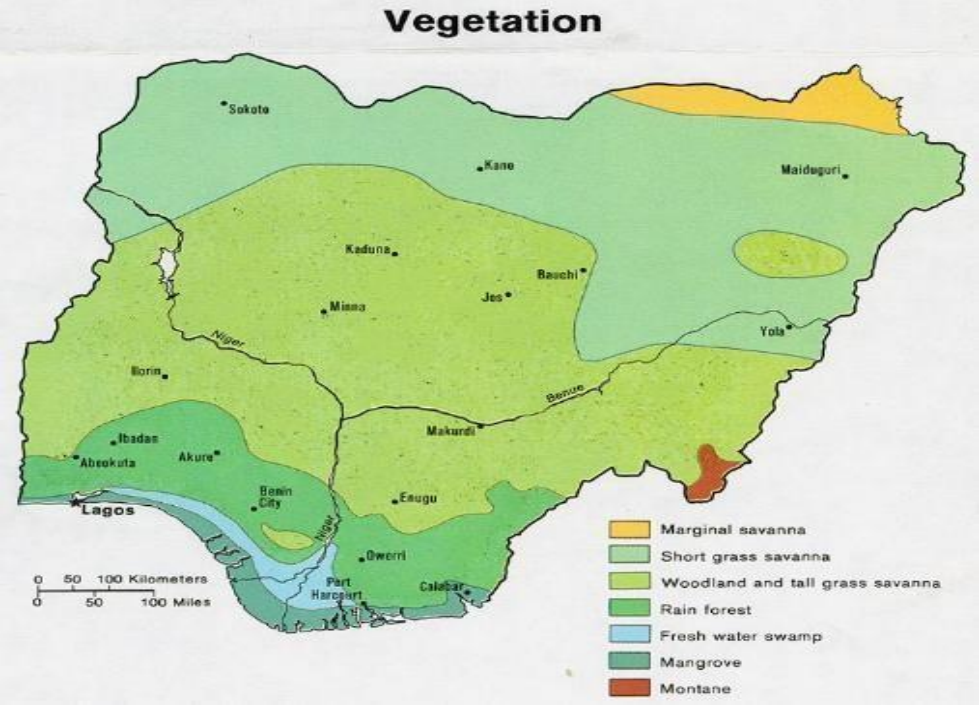


Figure 4.3: Map of Nigeria Showing distribution of Vegetation

Nigeria's vegetation is broadly controlled by variations in rainfall, temperature, humidity, and soil characteristics across the country. In the southern humid tropical forest zone, where rainfall is high and prolonged, the environment supports a wide range of plantation and food crops such as cocoa, oil palm,

rubber, coffee, yam, cassava, cocoyam, maize, rice, groundnut, melon, and cowpea. However, in parts of the eastern region and coastal areas, excessive rainfall has resulted in severe soil leaching and erosion, reducing soil fertility in some locations.

In contrast, the northern part of Nigeria, which accounts for a significant proportion of the country's vegetative zones, experiences lower annual rainfall and a shorter rainy season. This region is dominated by savannah ecosystems, which provide favourable conditions for grazing livestock such as cattle, sheep, goats, camels, horses, and donkeys. The savannah vegetation is therefore closely linked to pastoral and agro-pastoral land-use systems.

Overall, Nigeria's natural vegetation zones have developed through the interaction of climate, rainfall, humidity, and soil properties. Over time, these natural systems have been substantially modified by human activities, including agriculture, grazing, settlement expansion, and fuelwood harvesting. Based on these environmental controls, Nigeria's agro-ecological zones are broadly classified into the following categories:

- Mangrove forest and coastal vegetation, occurring mainly in the Niger Delta region
- Freshwater swamp forest, commonly found in parts of Ogun, Benin, Imo States, and the Niger Delta
- Tropical high forest zone, extending from western Nigeria through parts of the Niger–Benue river system into the southeastern region
- Derived Guinea savannah, which represents a transition zone between the tropical rainforest and the Guinea savannah
- Guinea savannah, the most extensive ecological zone in Nigeria, covering nearly half of the country and stretching from parts of southern Nigeria through Oyo State to areas beyond Zaria in Kaduna State
- Sudan savannah (short grass savannah), dominant in the northwestern region and extending across much of northern Nigeria
- Sahel savannah (marginal savannah), located in the extreme northeastern part of the country and influenced by advancing desert conditions
- Montane vegetation, found in high-altitude areas such as the Jos Plateau, Mandara Mountains, Adamawa Highlands, and Obudu Plateau

4.10.2 Vegetation of Sokoto State and the Study Area

At the time of the assessment, the immediate footprint of the proposed LPG project site in Birnin Kebbi Road, Bodinga Local Government Area, Sokoto State, exhibited sparse and discontinuous vegetation cover. This condition reflects prolonged anthropogenic disturbance arising from cultivation, livestock grazing, fuelwood harvesting, and settlement expansion. As a result, much of the original vegetation within the project boundary has been modified, leaving scattered shrubs and grasses with low canopy density.

Within an approximate 3 km radius of the site, the vegetation is characteristic of the Sudan Savannah ecological zone, which predominates in Sokoto State. The Sudan Savannah is typified by open woodland with widely spaced, drought-resistant trees interspersed with seasonal grasses. Vegetation density increases slightly during the rainy season but becomes markedly sparse during the prolonged dry season due to moisture stress and high evapotranspiration rates.

Dominant tree species observed in the surrounding area include Neem (*Azadirachta indica*), Baobab (*Adansonia digitata*), *Acacia nilotica*, *Faidherbia albida*, and *Parkia biglobosa*. These species are well adapted to semi-arid climatic conditions and are commonly associated with human-influenced savannah landscapes. Additional species recorded include *Tamarindus indica*, *Mangifera indica*, *Psidium guajava*, *Piliostigma thonningii*, *Lannea acida*, and *Ficus thonningii*, occurring in scattered and uneven distributions.

Ground vegetation is primaZAGRy composed of short annual grasses and herbaceous plants that regenerate during the wet season but dry out significantly during the harmattan period. Overall, the vegetation structure reflects a typical Sudan Savannah ecosystem shaped by semi-arid climatic conditions and sustained anthropogenic pressure, with moderate species diversity but generally low biomass and canopy cover within the project area.

The plant species identified within the study area comprise trees, shrubs, and herbaceous plants and are presented in Table 4.7. Given the low vegetation density within the actual project footprint, the proposed LPG facility is not expected to result in significant loss of natural vegetation. Nevertheless, appropriate vegetation management and site rehabilitation measures will be implemented to minimize ecological disturbance and maintain the existing environmental balance within Birnin Kebbi Road and its surrounding communities.

4.10.3 Vegetation Sampling Methods

A stratified random sampling approach was adopted to adequately capture variations in land cover within the project area. The site was divided into five topographic strata, designated as A, B, C, D, and E. Stratum A represents the perimeter of the proposed project site, located at the centre, while strata B, C, D, and E comprise the surrounding farmlands adjacent to the project site.

Vegetation composition was assessed through the identification, enumeration, and documentation of all plant species and individual plants encountered within the sampling plots, including trees, shrubs, lianas, and herbaceous species. Transects were further subdivided into smaller units based on topographic variation and observable differences in vegetation composition, and sampling was carried out using quadrats placed at 50-metre intervals to ensure adequate spatial coverage and representativeness.

Six (6) quadrats were laid in each transect being 100m × 100m for tree strata, 50m × 50m for shrubs, and 10m × 10m for herbs. This sampling approach ensured a representative sample of the different physical and floristic features of the study area was captured. Diameter at breast height (dbh) of plants with vertical height of 3m were measured at 1.3m from the ground level, using diameter tape. Biometric field analysis involved morphometric measurements, enumeration and application of allometric equations. Vegetation variables investigated included:

- Plant crown cover.
- Tree density.
- Species diversity.
- Basal area.
- Diameter at breast height.

Distance-based (point-centre quarter) technique was employed to determine mill the plant cover. The distance technique also allowed density of flora composition to be calculated, if the average space occupied by individual plant can be determine. That is, this technique assumes:

i. Plants occupy circular areas; and
ii. Plants are randomly distributed.

Tree density is therefore determine using the equation:

$$D = \frac{\overline{\quad}}{(Xd)2} \qquad A$$

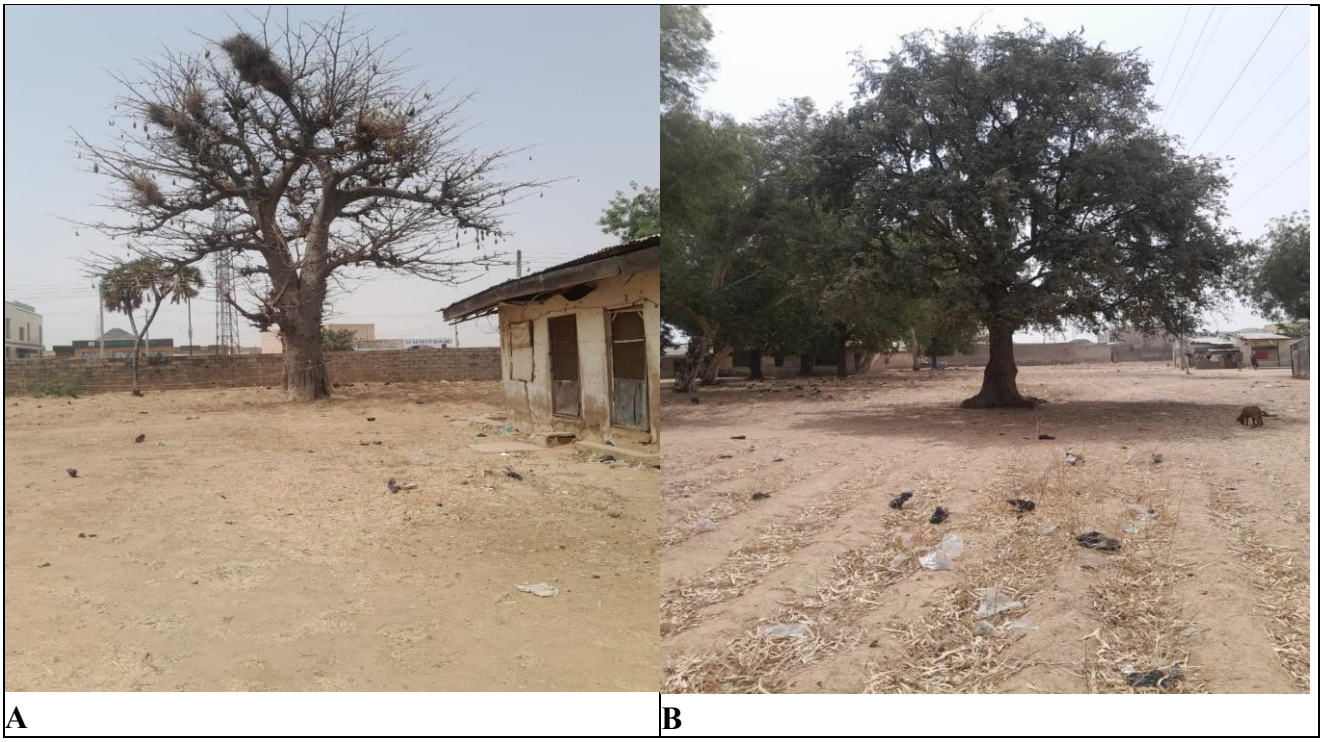
Where:

D= density

A= area of interest (e.g. m^2)

d= distance measured in the field

X= varies depending on assumptions about distance between plants or points to a plant.



A **B**

Plate 4.3: Representatives of Vegetation Sampling Points

4.10.4 Vegetation Structures and Physiognomy of the Study Area

The vegetation is a typical Sudan Savannah type, characterized by sparsely distribution of trees, shrubs and herbaceous flora. It is true that the variation in plant cover on the global and local scales is mostly determine by the amount of rainfall in such area (Daudu et al., 2017) and the influences posed by anthropogenic activities. The vegetation of this area is a typical woodland savannah; both trees and shrubs abound, and the physiognomic classification of this savannah depends on the woody plants.

One vegetation types exist here, the 'Savannah' vegetation. It has a clearly defined structure:

- An emergent layer of tall trees, mostly above 10m in height, which is called the megaphanerophytes.
- A middle storey of much smaller trees less than 10m in height, also known as mesophanerophye and
- A ground layer which comprises of predominantly of herbaceous plants as well as lianas

(woody climbers) is also common in this area.

The trees profile shows a tree stratum 5-15m high without canopy. Below this tree stratum is a stratum of shrub also with an irregular canopy, between 3-7m high. Finally, is the herb stratum consisting mainly of members of the Asteraceae and Poaceae, growing up to about 50 cm to 300 cm high.

4.10.5 Floristic Composition, Distribution, Density and Diversity of the Study Area

A large number of factors are in operation in determine the distribution of floristic components of vegetation, and the study to elucidate these factors is an important ecological objective. Several explanations advanced for the existence of savanna have been linked to soil either as the primary factor or that it has an indirect effect (Ubom and Isichei, 1995). Many of these soil phases with discrete vegetation units abound in the Savanna. These repeated occurrences of certain vegetation associations on different soil within the Savanna are a subject of study.

Classification and distribution of plant species as well as habit type and plant species composition in the study area are presented in *Table 4.9*. The table revealed some interesting information about the plants as well as their compositions. The floristic composition of the project area is somewhat diverse in species even over a seemingly heterogeneous area. A total of forty-five (45) plant species belonging to fifteen (15) families were recorded in transects surveyed and comprising of both woody and herbaceous flora. Ten (10) species representing about 22% of the censored species were herbs; five (5) species representing about 11% are lianas, while five (5) plant species representing about 11 % were shrubs and twenty-five (25) species representing about 55% were trees (*Figure 4.1*). Most of the herbaceous members encountered are those known to grow in secondary forest, savannah woodlands and disturbed habitats (Daniel, 2001).

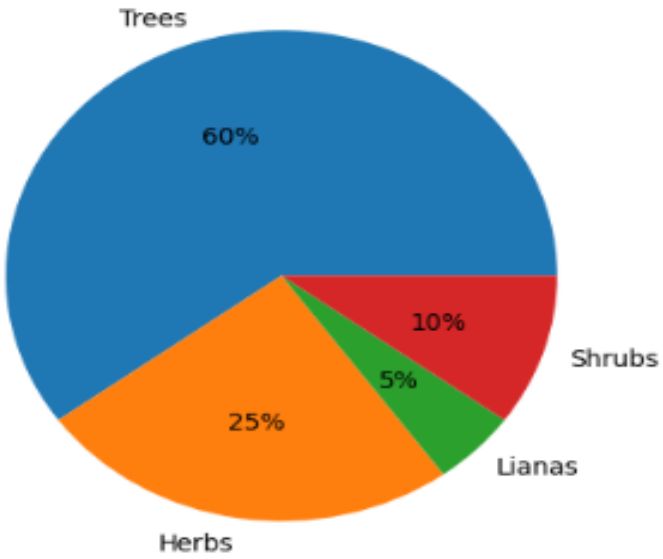


Figure 4.4: Habit Composition of the Flora Community in the Project Area

4.10.6 Species Abundance

Species abundance is the number of individuals per species. It is important in determining composition of organisms living in a habitat. The three most abundant plant species within the project area were *Cassia tora* (91), *Azadirachta indica* (65), Senna siamea (41). Meanwhile, the three least abundant plant species were:Waltheria indica (2), Syzygium guineensis (1) and *Cynometra vogelii* (1). The three most abundant families were Fabaceae, Asteraceae and Poaceae, three least abundant families include: Asparaceae, Combretaceae and Lythraceae. (figure 1) presents the families with the highest individuals were the Fabaceae (278), Meliaceae (66) and Poaceae (62). Lastly Laminaceae (11) Vitaceae (7) and Bignoniaceae (2) are the families with least individuals (*Figure 2 and Table 1*). The mean diameter at breast height (Dbh), height and density per hectare of the surveyed tree species were presented in table 2. The Dbh was 0.478m while the mean height was 6.3m, basal area was 0.20m^2/ha. The total density of tree species in the site was 51trees per hectare.

Table 4.7: Classification and Distribution of Plant Species in the project Areas

SN	*SPECIES NAME*											
		Family name	**Hausa name**	**Common name**	**Habit**	**Control**	**A**	**B**	**C**	**D**	**E**	**TOTAL**
1	*Ageratum conyzoides*	Asteraceae		Goat Weed	Herb	2	2	12	2	2	6	**26**
2	*Ampelocissus Africana*	Vitaceae			Liana	2						**2**
3	*Andropogon tectorum*	Poaceae	Gábàà	Bread Grass	Herb	5	5	5	6	2	4	**27**
4	*Anogeissus leiocarpus*	Combretaceae	Márkéé	Axle wood	Tree	5	4	2	2	2	2	**17**
5	*Asparagus africanus*	Asparagaceae	Tárkónɓéérää	Climbing Asparagus	Tree	4	5	4	4	4	4	**25**
6	*Aspilia Africana*	Asteraceae	Kalanwuka	Haemorrhage Plant	Tree	2	2	2	2	2		**10**
7	*Azadirachta indica*	Meliaceae	Dóógónyáàròò	Neem Tree	Tree	15	10	10	4	11	15	**65**
8	*Acacia nilotica*	Fabaceae	Bagaruwa	Gum Arabic tree	Tree	2		2	1			**5**
9	*Vachellia sieberiana*	Fabaceae	Farar kaya	Paperbark tree	Tree			1	2	1	3	**7**
10	*Adansoniya digitata*	Malvaceaea	Kuka	African baobab	Tree	3	2	2	2	2	2	**13**
11	*Cissus quadrangularis*	Vitaceae	Ɗáɗɗòòríí	Adamant Creeper	Liana	2		1		1	1	**5**
12	*Cyperus compressus*	Cyperaceae	Aya	Poorlandflatsedge	Herb	10						**10**
13	*Cyperus rotundus*	Cyperaceae	Aya	Tigernut	Herb	1					1	**2**
14	*Lawsonia inermis*	Lythraceae	Lalle	Henna tree	Shrub	3	5	2		1	1	**12**
15	*Ficus thonningi*	Moraceae	Cediya	Dirimi	Herb	2		2	1	1	1	**7**
16	*Ficus platyphylla*	Moraceae	Gámjì	Broad Leaf Fig	Tree		1	1		1	1	**4**
17	*Ficus sycomorus*	Moraceae	Baure	Fig Mulberry	Tree		2		1	2	1	**6**
18	*Mangifera indica*	Anacardiaceae	Màngwàrò	Mango	Tree	1	2	3	1	5	1	**13**
19	*Ceiba pendendra*	Malvaceae	Rimi	Kapok	Tree		1		1	1		**3**

20	*Panicum maximum*	Poaceae	Gáárìjíí	Panicum	Herb	2	3	10	1	1	1	**18**
21	*Parkia biglobosa*	Fabaceae	Dóòráwà	Locust Bean Tree	Tree		2	1	1	3	4	**11**
22	*Pennisetum purpureum*	Poaceae	Yambama	Elephant grass	Herb	3	2	2	3	3	4	**17**
23	*Piliostigma thonningii*	Fabaceae	Kárgóó	Piliostigma	Tree	3	3	1		1		**8**
24	*Psidium guajava*	Myrtaceae	Góóbàà	Guava	Tree	2					2	**4**
25	*Senna siamea*	Fabaceae		Cassia	Tree	1	20	3	2	5	10	**41**
26	*Sida acuta*	Malvaceae	Khada	Hornbean Leaf	Herb	11	2	1	3	1		**18**
27	*Hyphaene thebaica*	Arecaceae	Goriba	Doum palm	Tree	12	5	11	2	3	6	**39**
28	*Vitex doniana*	Fabaceae	Dínyáá	Black plum	Tree			2	1			**3**
29	*Waltheria indica*	Fabaceae	Yankufa	Sleeping morning	Tree				2			**2**
30	*Prosopis africana*	Fabaceae	Kirya	African mesquite	Tree		5		1	3		**9**
31	*Syzygium guineensis*	Myrtaceae	Malmo	Waterberry	Tree					1		**1**
32	*Tamarindus indica*	Fabaceae	Tsamiya	Tamarind	Tree		3	1	3	4	2	**13**
33	*Sclerocarya birrea*	Anacardiaceae	Danya	Marula	Tree		2				1	**3**
34	*Guera senegalensis*	Laminaceae	Malena	Beechwood	Shrub		2	3	2	1	1	**9**
35	*Carica papaya*	Annonaceae	Gwanda	Paw paw	Tree		2	2	4	2	2	**12**
36	*Eucalyptus camaldulensis*	Myrtaceae	Turare	River red gum	Tree		20		1		4	**25**
37	*Vitex doniana*	Laminaceae	Dinya	Black plums	Tree		1				1	**2**
38	*Cassia tora*	Fabaceae	Tafasa	Sickle senna	Herb		11	5	20		55	**91**
39	*Borassus aethiopum*	Arecaceae		African fan palm	Tree		1	3	2		1	**7**
40	*Jacaranda mimosifolia*	Bignoniaceae	Gatsari	Jacaranda	Tree		2					**2**
41	*Entada africana*	Fabaceae	Tawatsa	African dream herb	Tree				1	2		**3**
42	*Cynometra vogelii*	Fabaceae			Tree						1	**1**

43	*Dalbergia boehimii*	Fabaceae		Indian rose wood	Tree			1	1			**2**
44	*Daniellia oliveri*	Fabaceae		African Copaiba Balsam	Tree			1		1	1	**3**
45	*Delonix regia*	Caesalpiniaceae		Flamboyant	Tree		5	2	5	2	1	**15**
46	*Diospyros mespilliformis*	Ebenaceae	Kanya	Jackal berry	Tree	1	2	1	3	1		**8**
47	*Ekerbergia senegalensis*	Meliaceae		Cape ash	Shrub					1		**1**
48	*Acacia nilotica*	Fabaceae	Bagaruwa	Egyptian acacia	Tree	5		1	1	2	2	**11**
49	*Ziziphus spina Christi*	Rhamnaceae	Magarya	Christ‟s thorn jujube	Tree	2	1		4	4		**11**
50	*Leptadenia hastata*	Apocynaceae	Yadiya		Liana	5	2	1		3		**11**
51	*Calotropis procera*	Apocynaceae	Tumfafiya	Sodom apple	Shrub	1	1	1	3		4	**10**
	TOTAL					**107**	**127**	**97**	**75**	**82**	**91**	**579**

27	*Piliostigmathonningii*	Fabaceae	Kárgóó	Piliostigma	Shrub	6	4	10	3	24	5	**52**
28	*Psidium guajava*	Myrtaceae	Góóbàà	Guava	Shrub	1	3	2	1	1	11	**19**
29	*Sansevieria liberica*	Moraceae	Móódà	Bowstring Hemp	Herb					43	34	**77**
30	*Scaevola sericea*	Malvaceae			Herb		105	43	34	55		**237**
31	*Senna obtusifolia*	Fabaceae		Foetid Senna	Herb	66		50	54	76		**246**
32	*Senna occidentalis*	Fabaceae		Negro coffee	Herb	78		56	64	89		**287**
33	*Senna siamea*	Fabaceae		Cassia	Tree					12		**12**
34	*Senna sieberiana*	Fabaceae	Áráhóó	Cassia Pods	Tree	1	1			1	1	**4**
35	*Setariapallide-fusca*	Rhamnaceae	Ƙyás	Yellow Foxtail	Herb	7			6	4		**17**
36	*Sida acuta*	Malvaceae	Khada	Hornbean Leaf	Herb	20	8		12	2		**42**
37	*Hyphaene thebaica*	Arecaceae	Goriba	Doum palm	Tree	6	3	3	1	7	30	**50**
38	*Vitellaria paradoxa*	Fabaceae	Káɗéé	Shea butter tree	Tree	3	1	3	2	2	2	**13**
39	*Vitex doniana*	Fabaceae	Ɗínyáá	Black plum	Tree	2	2	1	2	1	3	**11**
40	*Waltheria indica*	Fabaceae	Yankufa	Sleeping morning	Shrub				1			**1**
41	*Ziziphus spina-christi*	Asteraceae	Kándíídà	Christ's Thorn	Tree	3				1	3	**7**
42	*Musa spp*	Musaceae	Ayaba	Banana	Tree	50						**50**
43	*Adansonia digitata*	Malvaceae		African Baobab	Tree	5	13	2	1	5	1	**27**
44	*Tamarindus indica*	Fabaceae	Tsamiya	Tamarind	Tree	4	17	4	3	26	8	**62**
45	*Sclerocaryabirrea*	Anacardiaceae		Marula	Tree						1	**1**
	TOTAL					**922**	**518**	**574**	**523**	**961**	**467**	**3,965**

Table 4.8: Species Floristic Indices of the project area

Floristic Features			**Results**
Species Attributes	Species Diversity		51
	Species Abundance		**579**
	Three most abundant plant species		*Cassia tora* (91), *Azadirachta indica* (65), Senna siamea (41)
	Least abundant plant species		*Waltheria indica* (2), *Cynometra vogelii* (1) and syzygium guineensis (1).
	Species habit	Herb	17.65%
		Lianas	5.88%
		Shrub	7.84%
		Trees	68.63%
Family Attributes	Family diversity		Asteraceae, Vitaceae, Poaceae, Combretaceae, Asparagaceae, Meliaceae, Fabaceae, Malvaceaea, Cyperaceae, Lythraceae, Moraceae, Anacardiaceae ,Myrtaceae, Arecaceae, Laminaceae, Annonaceae, Bignoniaceae, Caesalpiniaceae, Ebenaceae, Rhamnaceae, Apocynaceae
	Three most abundant family		Fabaceae, Moraceae and Poaceae
	Three least abundant family		Lytraceae, Combretaceae and Bignoniaceae
	Families with most species		Fabaceae (15), Moracea (3) and Poaceae (3)
	Families with least species		Lytraceae (1), Combretaceae (1) and Bignoniaceae (1)
	Five Families with most individuals		Fabaceae (278), Meliaceae (66) and Poaceae (62)
	Five Families with least individuals		Laminaceae (11) Vitaceae (7) and Bignoniaceaee (2)

Table 4.9: Some Trees around the Project Area

 *Tamarindus indica* (Tamarind) aPetrol Filling Station savanna plant	 *Piliostigmathonningii*, one of the common plant species in the project site
 *Adansonia digitata*, a common savannah tree	 *Azadirachta indica* (Neem), the most abundant tree species in the project site

Hyphaene thebaica, a typical savannah tree

Parkia biglobosa (Locust Bean Tree), aPetrol Filling Station savannah tree

4.10.7 Species Diversity Indices

Several important variables were calculated for all surveyed transects. These include; number of individuals, number of species, dominance, evenness, Margalef index and Shannon's diversity index as presented in *Table 4.12*. Diversity varied from 1.0 to 3.3; the highest diversity corresponded with Transect **D** which has great flora diversity and abundant flora; this was followed by the control transect. The least diverse was transect **E** with 467 individuals and 24 species while the most diverse transect is **D** (diversity = 3.322 with 961 individuals and 40 species); this was followed by **control** transect (diversity =2.825 with 922 individuals and 37 species). High value of H represents more diverse community; thus, in terms of diversity of the transect sites, D>Control > E>C> B > A.

Evenness or equitability values for all transects showed some variations and the results for evenness is similar to that of equitability in the transect points. The least evenness (0.6238) was observed at transect E (with 30 species and 467 individuals), however, the highest evenness (0.7903) was observed in transect D with 961 individuals and 40 species. The results of the Margalef index are quite similar to those of Shannon's index to a greater extent but dissimilar from Evenness. The highest Margalef Index (5.043) was found in transect D while the lowest (1.009) was found in transect A. Also, the second highest Margaale Index (4.832) is found in the control transect. Margalef index of species richness indicated that all the stations were ecologically diverse and they vary in stability. It should be noted that any site with higher diversity index is more stable or indicating less stress than sites with lower values. In this case, Transect A is the most stressed of the other sites.

Table 4.10: Biodiversity Indices of the Project Area

	Control	A	B	C	D	E
Taxa_S	27	34	34	35	35	33
Individuals	107	138	102	95	82	146
Dominance_D	0.06839	0.067	0.05959	0.06903	0.04729	0.1673
Simpson_1-D	0.9316	0.933	0.9404	0.931	0.9527	0.8327
Shannon_H	2.96	3.099	3.145	3.172	3.316	2.583
Evenness_e^H/S	0.715	0.652	0.6831	0.6819	0.787	0.4013
Margalef	5.564	6.697	7.135	7.466	7.715	6.421
Equitability_J	0.8982	0.8787	0.8919	0.8923	0.9326	0.7388

4.10.8 Status and Conservation Interest

Plant species encountered in the study area were categorized into three conservation status according to the IUCN Red List of Threatened Species Status (2020-2) (*Table 4.13*). Summary is presented thus:

- Data Deficient (DD)- Thirty-nine (39) plant species encountered.
- Least Concerned (LC)- Seven (7) species.

Critical Habitat

Critical habitat determination using IFC PS6 criteria indicates that the study area is not a "critical habitat" due to the following:

- There were no critically endangered and/or endangered tree species identified; and
- No evidence of habitat of significant importance to endangered tree species.

Table 4.11: International Union for Conservation of Nature (IUCN) status for Plant Spp

SN	*SPECIES NAME*	FAMILY NAME	COMMON NAME	IUCN STATUS
1	*Ageratum conyzoides*	Asteraceae	Goat Weed	DD
2	*Aloe buettneri*	Asphodelaceae	West African Aloe	DD
3	*Ampelocissusafricana*	Vitaceae		DD
4	*Andropogon tectorum*	Poaceae	Bread Grass	DD
5	*Anogeissusleiocarpus*	Combretaceae	Axle wood	DD
6	*Asparagus africanus*	Asparagaceae	Climbing Asparagus	DD
7	*Aspiliaafricana*	Asteraceae	Haemorrhage Plant	DD
8	*Azadirachta indica*	Meliaceae	Neem Tree	DD

9	*Balaniteaegyptica*	Zygophylaceae	Desert Date	DD
10	*Ceiba pentandra*	Bombacaceae	Kapok	DD

SN	***SPECIES NAME***	**FAMILY NAME**	**COMMON NAME**	**IUCN STATUS**
11	*Cissus quadrangularis*	Vitaceae	Adamant Creeper	DD
12	*Cyperus compressus*	Cyperaceae	Poorlandflatsedge	DD
13	*Cyperus rotundus*	Cyperaceae	Tigernut	DD
14	*Detariummicrocarpum*	Fabaceae	Sweet Detar	DD
15	*Dichrostachissp*	Fabaceae	Princess's Earing	DD
16	*Ficus thonningi*	Moraceae	Dirimi	DD
17	*zFicusplatyphylla*	Moraceae	Broad Leaf Fig	DD
18	*Ficus sycomorus*	Moraceae	Fig Mulberry	DD
19	*Mangifera indica*	Anacardiaceae	Mango	DD
20	*Mitracarpusscaber*	Rubiaceae	Deer Grass	DD
21	*Nauclea latifolia*	Rubiaceae	African Peach	DD
22	*Nelsoniacanescens*	Poaceae	Blue Pussyleaf	DD
23	*Newbouldialaevis*	Poaceae	Boundary Tree	DD
24	*Panicum maximum*	Poaceae	Panicum	DD
25	*Parkia biglobosa*	Fabaceae	Locust Bean Tree	DD
26	*Pennisetum purpureum*	Poaceae	Elephant grass	DD
27	*Piliostigmathonningii*	Fabaceae	Piliostigma	DD
28	*Psidium guajava*	Myrtaceae	Guava	DD
29	*Sansevieria liberica*	Moraceae	Bowstring Hemp	DD
30	*Scaevola sericea*	Malvaceae		DD
31	*Senna obtusifolia*	Fabaceae	Foetid Senna	DD
32	*Senna occidentalis*	Fabaceae	Negro coffee	DD
33	*Senna siamea*	Fabaceae	Cassia	DD
34	*Senna sieberiana*	Fabaceae	Cassia Pods	DD
35	*Setariapallide-fusca*	Rhamnaceae	Yellow Foxtail	DD
36	*Sida acuta*	Malvaceae	Hornbean Leaf	DD
37	*Hyphaene thebaica*	Arecaceae	Doum palm	DD
38	*Vitellaria paradoxa*	Fabaceae	Shea butter tree	DD
39	*Vitex doniana*	Fabaceae	Black plum	DD
40	*Waltheria indica*	Fabaceae	Sleeping morning	LC
41	*Ziziphus spina-christi*	Asteraceae	Christ's Thorn	LC
42	*Musa spp*	Musaceae	Banana	LC
43	*Adansonia digitata*	Malvaceae	African Baobab	LC
44	*Tamarindus indica*	Fabaceae	Tamarind	LC
45	*Sclerocaryabirrea*	Anacardiaceae	Marula	LC
	TOTAL			LC

N.B: DD (Data Deficient); LC (Least Concerned); VU (Vulnerable)

4.10.9 Animals (Fauna)

The landscape is stratified into several habitats, providing the landscape with a habitat of biological importance. However, faunal composition and abundance was poor given that the area had been occupied by the agricultural and industrial activities for a long time and that has led to the relocation and possible decrease by hunting in the region.

Despite the very poor abundance of fauna in the region, the study area is rich in avifauna (birds) and arthropod (insects) taxa but massively low in mammals. The low mammalian species diversity would imply that the ecosystem integrity has been distorted by the persistent and increased human disturbance in the area. Therefore, the relatively low numbers of these mammals are indicative that the ecosystem has reached a tertiary state of anthropogenic impact. Their tertiary state is one in which the ecosystem has become impaired and is feared that it may not recover fully even if actions are taken in the medium-term due to the absence of key species (Theodore and Helmut, 2006).

Fauna Sampling Methods

The sampling methods adopted for wildlife assessment were in accordance with the acceptable international standards and summarized in Table 4.11.

Table 4.12: Methods of Terrestrial and Aquatic Fauna Assessment

Fauna	Sampling Methods
Terrestrial fauna	Direct and indirect sighting of animals and interviews/discussions with natives and residents within and around the project areas. Direct field investigation was carried out in the project area.
Terrestrial Invertebrates	***Insects Diversity Assessment*** Three principal methods were employed to obtain information on abundance, diversity and significance of insect community in the project area. The methods are: ***Handpicking*:** This is the picking of insects with fingers (for insects that do not bite or sting) or forceps. The specimens were transferred to specimen bottles, labelled and preserved for identification. ***Sweep Net*:** The sweep net consists of net with open end which is 30 cm in diameter. It was used for collecting flying and hopping insects on low vegetation. The specimens were transferred to a killing bottle before labelling and pining. ***Direct Sighting*:** Common insects were observed and documented based on their characteristic physical features. ***Molluscs Assessment*** Molluscs assessment was by direct observation of snails on plant parts, on land, on wharves and water. Identification was done by a Malacologist using relevant texts and taxonomic keys.
Terrestrial Vertebrates	Terrestrial vertebrates including amphibians, birds, reptiles and mammals were identified and their distribution and biostatistics were studied
Amphibians	***Direct Observation:*** assessed by direct search and observation for morphological keys. ***Indirect Observation:*** indirect observation for eggs (on possible substrates).

Avian Species / Bird	***Direct Observation:*** Direct sightings using handheld binoculars and cameras. ***Indirect Observation*:** This method focused on taking other forms of bird records apart from sight and sound (call), such as feather, droppings and nesting sites. ***Bird Identification and Biological Nomenclature:*** Notes (and sometimes photographs) were taken of birds that were not identified in the field for post field identification with Birds of West Africa field guide by Theodore and Helmut (1986). Bird nomenclature and taxonomy was done according to Bird Life International classification.
Reptiles	***Direct Observation:*** Direct sighting of reptiles as they crawl or limp through thickets. ***Indirect Observation*:** This method focused on observing prints of the crawling paths as well as skin residues from moulting. Interactions with the residents were also employed given the difficulty of large reptile sightings in short duration of such filed surveys as this.
Mammal	Footpaths in the study sites were extensively traversed to locate and identify mammals in the area. Knowledge of mammalian behaviours was also employed as guide especially for small mammal's sightings. The following methods were used to ascertain the presence of mammalian species: ***Direct Observation:*** This entailed recording animals seen or heard in the field. Animal observations were recorded while walking a continuous line transect of 100 m to 200 m. ***Indirect Observation*:** This involves mammal observation through sighting of signs (e.g. remains of dead individuals, footprints, nests, dens, trails and runways, faeces, and food residues) left by the animals. ***Informal Interviews and Discussions with Farmers:*** Focus group and individual interviews were conducted during the mammal assessment to collect information on animal sightings within and around the study sites. **Statistical Analysis** The results were subjected to diversity indices assessments using the PAST software.

4.10.10 Conservation Status of Animal Species

The conservation status of the animal species in the project area was evaluated using the International Union for Conservation of Nature (IUCN) Red List Categories and Criteria. The IUCN Red List of Threatened Species is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of animal, fungi and plant species and their links to livelihoods. The IUCN Red List is set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies. The aim is to convey the urgency of conservation issues to the public and policy makers, as well as help the international community to try to reduce species extinction.

Species are classified by the IUCN Red List into nine groups as follows:

- Extinct (EX) – No known individuals remaining.
- Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.
- Critically endangered (CR) – Extremely high risk of extinction in the wild.
- Endangered (EN) – High risk of extinction in the wild.
- Vulnerable (VU) – High risk of endangerment in the wild.
- Near threatened (NT) – Likely to become endangered in the near future.
- Least concern (LC) – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.

- Data deficient (DD) – Not enough data to make an assessment of its risk of extinction.
- Not evaluated (NE) – Has not yet been evaluated against the criteria.
- When discussing the IUCN Red List, the official term "threatened" is a grouping of three categories: Critically Endangered, Endangered, and Vulnerable.

Ecosystem Services

Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems; e.g food, freshwater, timber, fibers, medicinal plants. (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; e.g carbon storage and sequestration, climate regulation, protection from natural hazards. (iii) cultural services which are the nonmaterial benefits people obtain from ecosystems; e.g sacred sites and areas of importance for recreation and aesthetic enjoyment. (iv) supporting services, which are the natural processes that maintain other services; e.g. soil formation, nutrient cycling and primary production.

Invertebrate Species

The results of invertebrate species assessment indicated that phyla Arthropoda and Mollusca were the predominant species in the study area.

The checklist of Arthropod species indicated that the predominant Orders were Lepidoptera, Odonata, Araneae, Isoptera, Coleoptera, Hymenoptera, Orthoptera, Diptera, and Hemiptera. Grasshoppers (i.e., Order Orthoptera, which appeared in several clusters) were the most ubiquitous arthropods across the area. Damages to tree stems by termites and other isopterans which use them as support for their mounds was evident. The tree stem provides reinforcements on which these insects construct their termitaria. These construction process leaves damaging impact on the plant as they become exfoliated and covered in earth. There were also evidences of active termite activities based on the abundance of termitaria in the area. *Plate 4.3* shows some of the invertebrate species observed in the study area. *Table 4.13* shows the classification of the invertebrate fauna observed in the project area.

Table 4.13: Classification of some Invertebrate Fauna observed in the Project Area

SN	Taxa /Common Names	Scientific Names	Order	IUCN Status
	Phylum Arthropoda			
1	Termites	*Marcotermes bellicosus*	Isoptera	NE
2	Common Black Ground Beetle	*Pterostic husmelanarius*	Coleoptera	NE
3	Rhinocerous beetle	*Pentodon idiota*	Coleoptera	NE
4	Grasshopper	*Zonocerus variegatus*	Orthoptera	NE

5	Black Ant	*Lepisiota sp.*	Hymenoptera	NE
6	House Flies	*Muscadomestica*	Diptera	NE
7	Monarch Butterfly	*Danaus plexippus*	Lepidoptera	NE
8	Plain Tiger	*Danaus chrysippus*	Lepidoptera	NE
9	Tawny Coster Butterfly	*Acraea lycoa*	Lepidoptera	NE
10	Centipede	*Lithobiusforticatus*	Chilopoda	NE

NE = Not endangered. *Source: EIA Fieldwork, 2025*

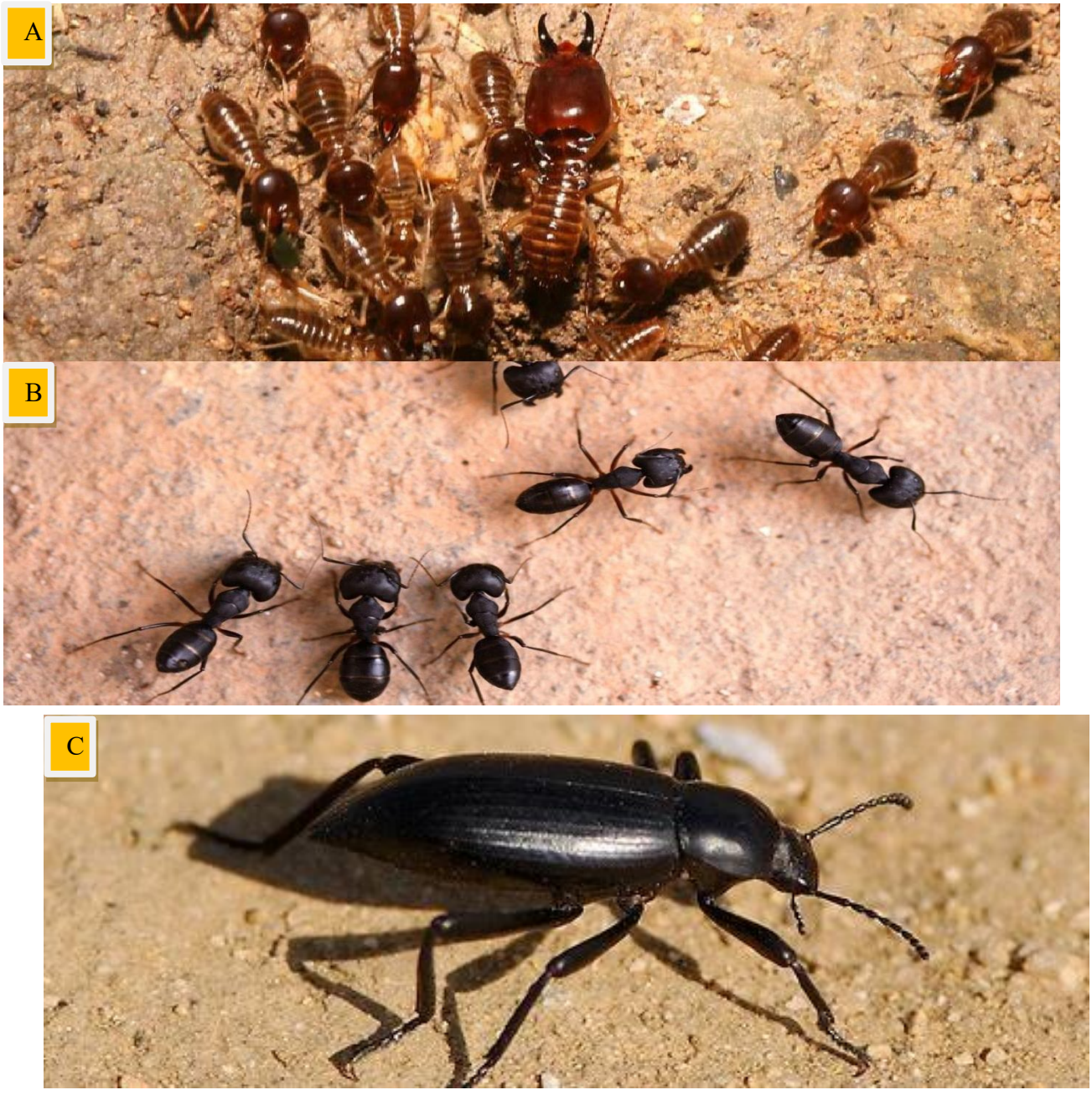


Plate 4.4: A = Termite B= Black Ant and C = Black Ground Beetle in the area

Vertebrate Species

The vertebrates observed during the sampling period belonged to Class Amphibians, Class Reptilia, Class Aves (Birds) and Class Mammalia. The Aves (birds) class was by far the most numerically dominant and most obvious vertebrate species – and among the Aves class, The Order Lepidoptera was the most abundant. *Table 4.13* presents the classification of the vertebrates in the project area.

Table 4.14: Vertebrates observed in the Project Area

SN	Common Name	Scientific name	IUCN Status	Status, Abundance Categories
	Class Aves			
1	Blue-Spotted Wood dove	*Turturafer*	LC	M/P/R, c
2	Black Faced Quailfinch	*Ortygospiza atricollis*	LC	M/P/R, c
3	Spotted Flycatcher	*Muscicapa striata*	LC	M/P/R, c
4	Lead Coloured Flycatcher	*Myioparusp lumbeus*	LC	M/P/R, c
5	Yellow-billed Kite	*Milvus migrans*	LC	M/P/R, c
6	Oriole Warbler	*Hypergerus atriceps*	LC	M/P/R, c
7	Common Weaver Bird	*Ploceus luteolus*	LC	R, c/f
8	Vitelline Masked Weaver	*Ploceus vitellinus*	LC	R, c/f
9	Village Weaver	*Ploceus cucullatus*	LC	R, c
10	Black headed weaver	*Ploceusnel anocephalus*	LC	R, lc/f
11	Intermediate Egret	*Egrettain termedia*	LC	R/M/V, u/c
12	Double Spurred Francolin	*Francolinus bicalcaratus*	LC	R, c
	Class Amphibian			
13	True toads	*Bufo regularis*	LC	NA
	Class Reptilia			
	Order Squamata			
14	Agama Lizard	*Agama agama*	LC	NA
	Class Mammalia			
	Order Rodentia			
15	Grass cutter /Greater cane rat	*Thryonomys swinderianus*	LC	NA
16	Giant rat	*Cricetomysemini*	LC	NA
	Order Carnivora			
17	Domestic dog	*Canis lupus familiaris*	LC	NA
	Order Artiodactyla			
18	Domestic goat	*Capra aegagrus hircus*	LC	NA
20	Domestic cow	*Bos Taurus*	LC	NA

Source: EIA Fieldwork, 2025

NOTE:Data was gathered from every survey technique employed which included Oral communication with hunters and residents. However, most of the data came from oral communication, given that were able to observe mostly the domestic animals. LC- Least Concern, NA- Not Applicable, R- Resident, M- Intra-African Migrant, P-Palearctic Migrant, V-Vagrant, l- local, c- common, f- fairly common, u- uncommon, s- scarce, r- rear

With respect to the Avifauna, other relevant categorization may also be applied. These include:

A. Status Categories

B. Abundance Categories (Borrow and Demey, 2008)

Status Categories

The status of each species is denoted by the following letters (in bold):

- Resident (R) - a species that resides within its range throughout the year and breeds; the opposite of a migrant.
- Intra-African Migrant (M) - a species that breeds in one part of Africa and spends the post- breeding season in a different area or appears only seasonally in other part.
- Palearctic migrant (P) - a species that breeds in the Palearctic region (Europe, North America and parts of Asia) and spends the northern winter in Sub-Saharan Africa.
- Vagrant (V) a species outside its normal range.

Abundance Categories

l- local
c- common, i.e., invariably encountered singly or in significant numbers within its normal habitat
f- fairly common, i.e. usually but not inevitably encountered within its normal habitat (= ' not uncommon' in BOWA 2001 or 'frequent').
u- uncommon, i.e. relatively frequently, but not regularly, encountered within its normal habitat s- scarce, i.e. only irregularly and infrequently encountered within its normal habitat
r- rear, i.e. rarely encountered, often implying fewer than 10 records

The category of the most frequently occurring abundance is placed first, e.g. 'f/s' means that the specie is more often (= in more countries) fairly common than scarce; 'u/lc' means 'uncommon to locally common'

The Aves observed in the study area can be said to be truly diverse with widely different status and abundance. A number of the species were categorized as intra African (M) and Palearctic migrants (P), transiting the savannah in order to avoid the Northern winter while others were residents. Only Ardeolaralloides and Egretta intermedia were vagrants. The abundance categories also varied markedly among the species.

Plate 4.5: A= Dove, B= Common weaver, C= A= Lizard and D= Giant Rat in the project area

Plate 4.6: Some of the domestic animals seen in the project area

4.11 SOCIO-ECONOMIC AND COMMUNITY CONSULTATION

The socio-economic study for the proposed Liquefied Petroleum Gas (LPG) refilling plant situated along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State was carried out using a well-structured and statistically reliable sampling framework designed to generate representative community data. Considering the presence of multiple settlements within the project vicinity and the differences in how these communities may experience project-related effects, a stratified random sampling technique was employed. This approach ensured that all relevant communities within the project's influence zone were adequately captured in accordance with established Environmental and Social Impact Assessment (ESIA) standards.

For this assessment, the Area of Influence (AoI) was delineated to include all settlements located within approximately three kilometres of the proposed project site. Identified communities were carefully categorized based on factors such as distance from the project location, settlement characteristics, estimated population, and the extent of their socio-economic interactions with the proposed facility. Each community was treated as a separate sampling unit, thereby ensuring balanced representation and preventing bias in the data collection process.

A sampling fraction equivalent to ten percent (10%) of the estimated household population was adopted across the study area. This proportion aligns with accepted practices in socio-economic baseline surveys, where a sampling range of five to ten percent is generally considered sufficient to produce reliable and meaningful results while remaining practical in terms of available time, logistics, and resources. The selected sampling size therefore provided an effective balance between analytical accuracy and field feasibility.

The allocation of questionnaires across the selected communities was done proportionally, taking into account both population size and proximity to the proposed LPG facility. Settlements located closer to the project site—where potential impacts such as increased traffic, employment opportunities, or environmental concerns are more likely to occur—were assigned a higher number of questionnaires. This ensured that the perspectives of those most likely to be affected were adequately reflected in the study findings.

Within each community, households were selected using a systematic random sampling method. Enumerators identified central landmarks such as major road intersections, community gathering points, or residences of traditional leaders, and then selected households at regular intervals based on settlement density. This method helped to maintain randomness, reduce selection bias, and improve the efficiency of field operations, particularly in areas where formal household records are not available.

Consultation with community leaders played an important role throughout the study. Traditional rulers, ward heads, and other key stakeholders were engaged during both the planning and data collection stages to provide guidance, validate population estimates, and facilitate community acceptance of the survey. In addition, field enumerators were recruited from within the local area and received appropriate training prior to deployment. Their familiarity with the local language and cultural context enhanced communication with respondents, reduced the likelihood of non-response, and improved the overall quality and credibility of the socio-economic data collected for the proposed LPG project

4.11.1 Traditional Administrative Structure

The traditional governance structure in Sokoto State, including Bodinga Local Government Area, is anchored in the long-established Hausa–Fulani emirate system that dates back to the era of the Sokoto Caliphate. At the apex of this system is the Sultan of Sokoto, who functions as the supreme traditional authority, providing leadership on cultural, religious, and customary matters across the state. Beneath this level, District Heads (Hakimai) are responsible for administering designated districts, while Village Heads (Dagatai) oversee the day-to-day affairs of individual communities, including those situated along the Birnin Kebbi Road corridor within Bodinga LGA.

This traditional framework exists alongside the formal local government system recognized by law. While the Local Government Council is charged with statutory governance and administrative responsibilities, traditional institutions continue to exert significant influence at the grassroots level. They play key roles in mobilizing community participation, resolving disputes, maintaining peace and order, and facilitating the communication of government policies and development initiatives. In addition, they serve as custodians of local traditions and Islamic values, and act as

important links between government authorities, project developers, and host communities, particularly in matters relating to land administration, security, and social welfare.

Within the household structure, leadership is typically vested in the head of the extended family, often the most senior male member, who represents the interests of the family in community matters. Decision-making generally follows a hierarchical and consultative process, beginning at the family level and extending to the Village Head, and where necessary, to the District Head and higher traditional authorities for further deliberation or approval. Consequently, any development project with potential community implications—such as the proposed LPG facility—requires prior engagement and consent through these established traditional institutions to ensure acceptance and smooth implementation.

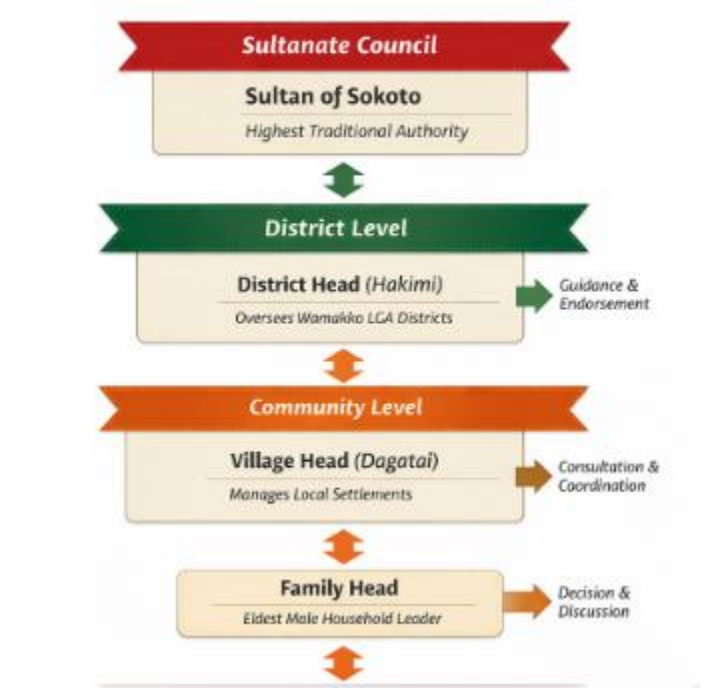


Figure 4.4: Traditional Administrative Structure of Host Community

4.11.2 Ethnicity and Cultural Heritage

The communities surrounding the proposed LPG project site along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State are characterized by a relatively uniform ethnic and cultural composition. The population is predominantly Muslim, reflecting the broader religious

landscape of Sokoto State. Hausa and Fulfulde are the principal languages spoken within the area, serving as the primary means of communication in everyday interactions, social activities, and local decision-making processes.

The cultural orientation of the area is deeply rooted in the Hausa–Fulani emirate tradition, under the overarching leadership of the Sultanate. Cultural and religious celebrations play an important role in reinforcing social cohesion and traditional values. Notably, events such as the Durbar festivals, held during the periods of Eid-el-Fitr and Eid-el-Adha, are widely celebrated and attract significant participation from community members. These occasions serve as important symbols of cultural continuity, communal identity, and respect for traditional authority.

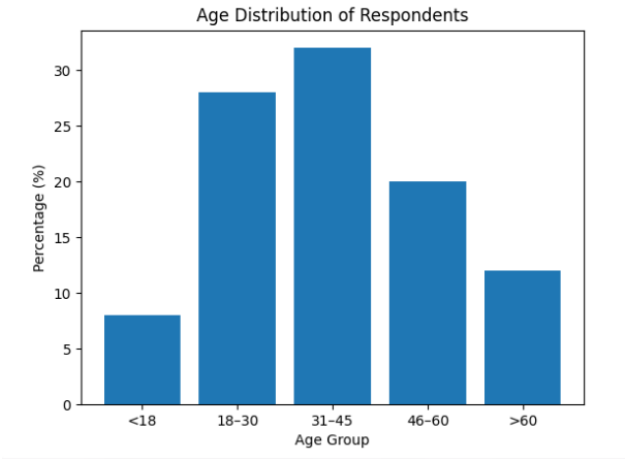
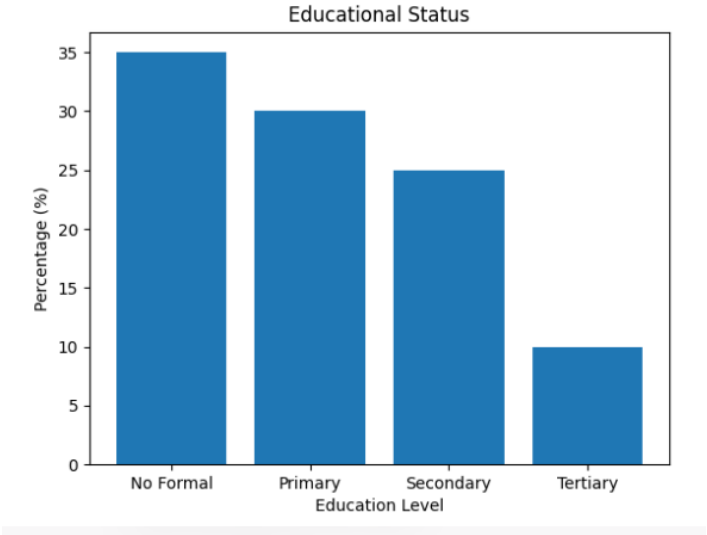
Social life within the Birnin Kebbi Road axis and its adjoining settlements is guided by clearly defined cultural norms and religious practices, which are essential considerations for the successful implementation of the proposed LPG facility. Among the commonly observed practices in the area are:

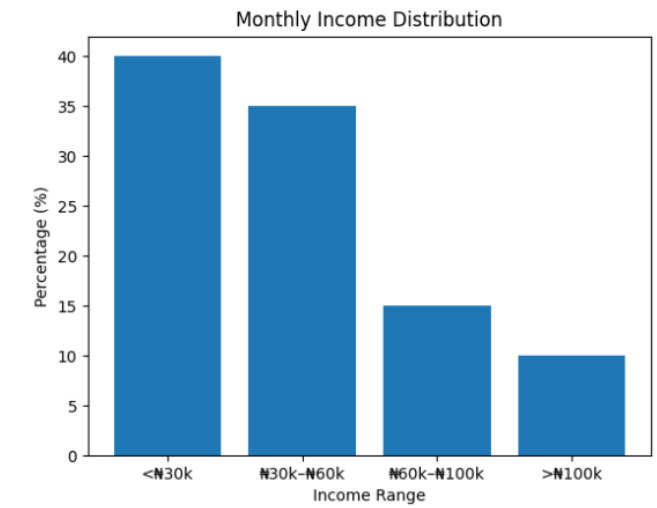
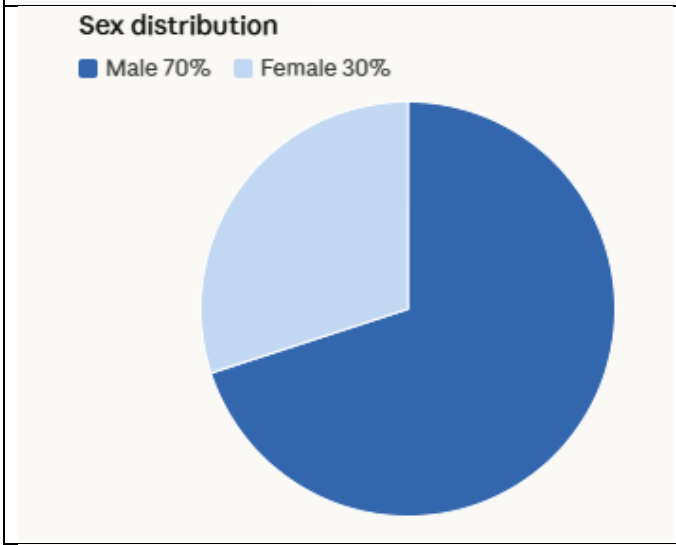
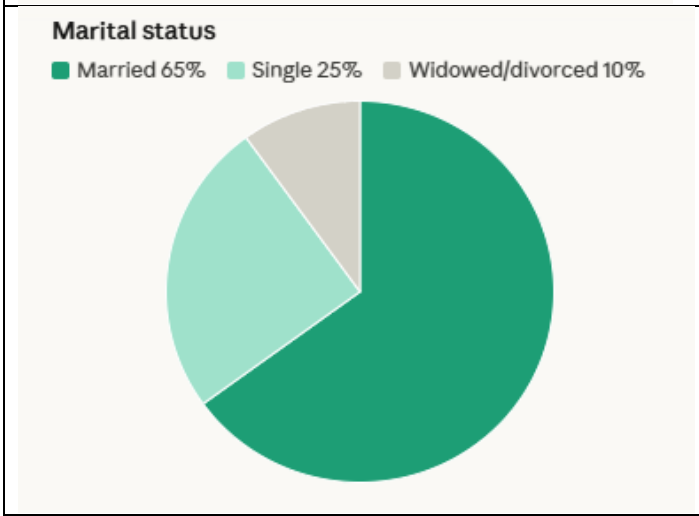
- High regard for places of worship, particularly mosques and designated prayer areas.
- Observance of daily prayer times, during which disturbances and unnecessary movement are generally avoided.
- Respect for the privacy of households, requiring permission before entry into residential premises.
- Cultural restrictions governing interactions with women, especially younger females, which must occur with appropriate family or guardian approval.
- Adherence to Islamic values that discourage activities such as smoking, alcohol consumption, and excessive noise or loud entertainment.

These socio-cultural expectations are fundamental to maintaining peaceful relations between the host communities and project personnel. Therefore, the implementation of the proposed LPG project along Birnin Kebbi Road should incorporate culturally appropriate engagement mechanisms, including continuous community consultation, sensitization of project staff, and strict adherence to local customs and traditions. Such measures will help to foster mutual respect, prevent social conflicts, and ensure sustained community support throughout the project lifecycle.

4.11.3 Demographic Characteristics of the Study Area

Table 4.15: Demographic Characteristics of the Project Area

	The age distribution shows that the majority of respondents fall within the **31–45 years (32%)** and **18–30 years (28%)** categories, indicating a relatively young and economically active population. This pattern is consistent with demographic characteristics of Sokoto State, where a large proportion of the population is within the working-age group. The implication for the proposed LPG project is positive, as this age group represents the primary labour force and potential workforce for both construction and operational phases.
	The educational profile indicates that **35% of respondents have no formal education**, while **30% and 25% possess primary and secondary education respectively**, and only **10% have tertiary education**. This reflects the general educational pattern in many parts of northern Nigeria. The relatively low level of formal education suggests the need for **community sensitization, safety awareness programs, and simplified communication strategies** during project implementation to ensure effective understanding of LPG safety practices.

	Income distribution shows that **40% of respondents earn below ₦30,000**, and **35% earn between ₦30,000–₦60,000**, indicating generally low-income levels. Only a small proportion (10%) earn above ₦100,000. This highlights the economic vulnerability of households within the project area. The proposed LPG project is therefore expected to provide **economic relief through job creation, improved livelihoods, and increased access to affordable energy**.
	The distribution shows **70% male and 30% female respondents**. This reflects the socio-cultural setting of Sokoto State where males are more likely to participate in public surveys and community decision-making. This implies that male perspectives dominate community opinions; however, gender-inclusive engagement should be ensured during project implementation.
	The majority of respondents are **married (65%)**, followed by **single (25%)** and **widowed/divorced (10%)**. This indicates a stable family structure typical of the region. Married respondents are more likely to prioritize household welfare, energy access, and safety, making them key stakeholders in LPG adoption.

4.11.4 Socio-Economic Infrastructure

4.11.4.1 Public Community Infrastructure

The availability of social infrastructure serves as an important indicator of the level of development within a community and provides insight into its social and economic needs. As part of the socio-economic baseline assessment conducted for the Environmental Impact Assessment (EIA) of the proposed LPG project in Birnin Kebbi Road, Bodinga Local Government Area, Sokoto State, an evaluation and mapping of existing public infrastructure within the host community were undertaken.

Findings from the infrastructure assessment indicate that Birnin Kebbi Road possesses a number of essential public facilities, including access roads, water supply sources, telecommunication services, local markets, schools, and other basic community amenities. These facilities support daily social and economic activities within the area and form the backbone of community life.

However, the assessment also revealed certain infrastructural deficiencies. In particular, sections of the major access road connecting Birnin Kebbi Road to surrounding settlements and the Bodinga township are in poor condition, with visible potholes and surface deterioration that may hinder smooth transportation. Such conditions could affect the movement of construction materials, equipment, and personnel during the implementation phase of the proposed LPG project.

Most of the existing infrastructure in Birnin Kebbi Road has been provided through state and local government efforts, as well as community and intervention initiatives. In view of the proposed LPG development, there is potential for the project to contribute positively to local infrastructure improvement, either directly through corporate social responsibility (CSR) initiatives or indirectly through increased economic activity within the community.

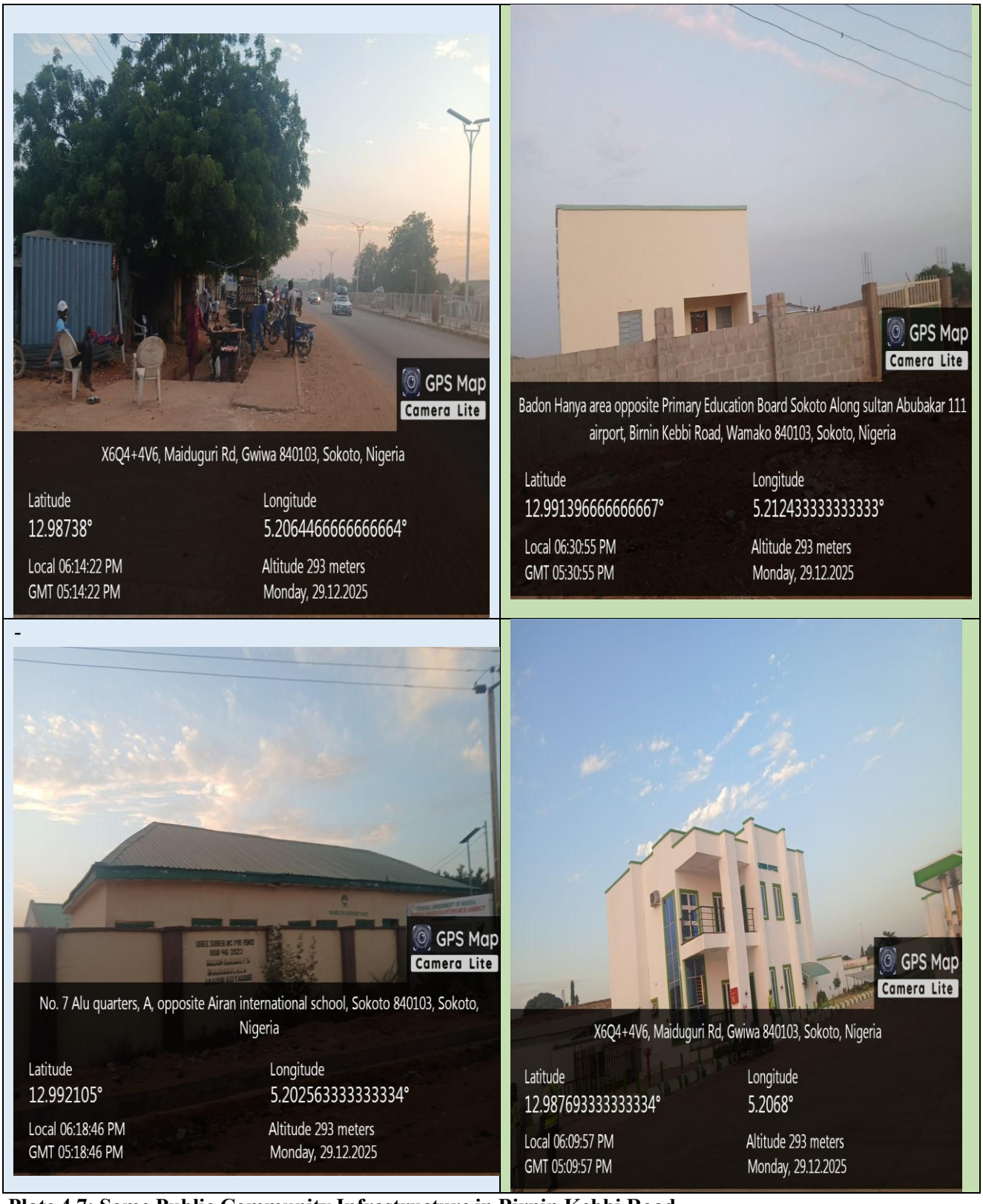


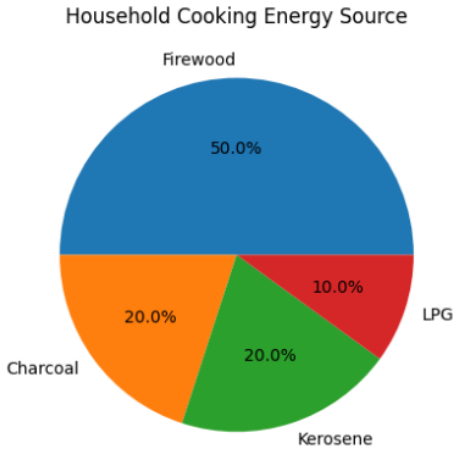
Plate 4.7: Some Public Community Infrastructure in Birnin Kebbi Road

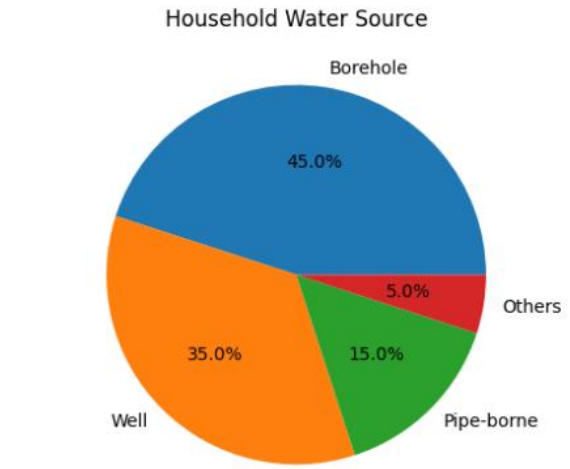
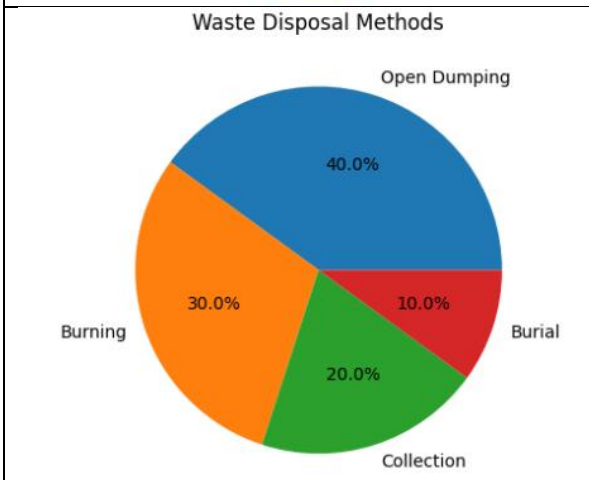
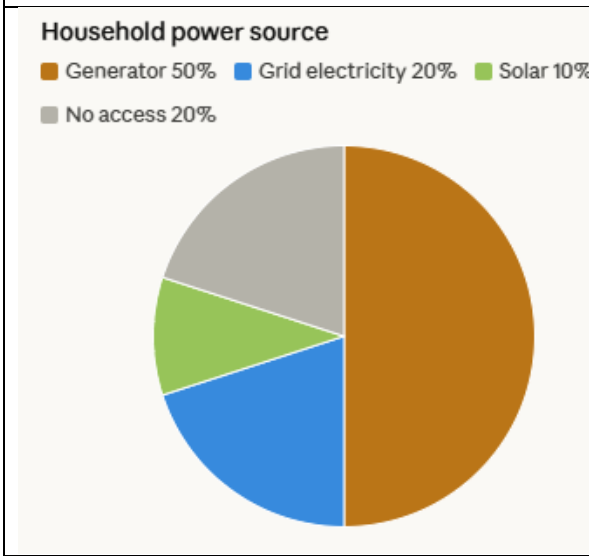
4.11.5 Household Infrastructure

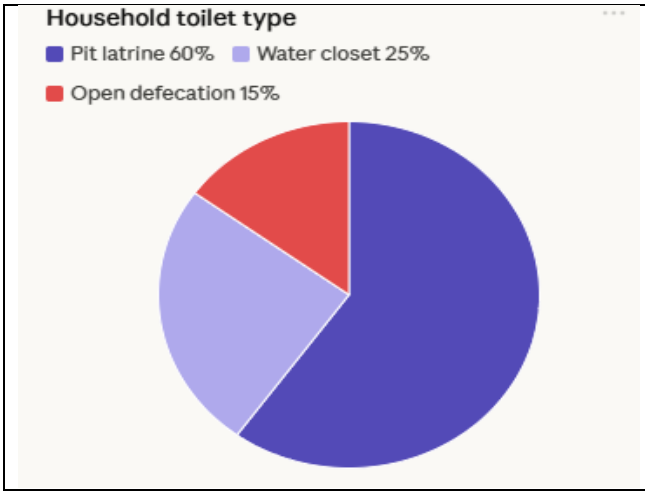
An assessment of household-level infrastructure was also undertaken to evaluate the living conditions of residents within Birnin Kebbi Road community, Bodinga LGA, as part of the socio-economic baseline studies for the proposed LPG project. The review focused on the availability and condition of basic amenities within individual households, including sources of water supply, sanitation facilities, electricity access, cooking energy sources, housing materials, and waste disposal methods.

This evaluation provides an understanding of the current standard of living of households in the project area and helps to identify existing gaps in basic services. The findings serve as a basis for determining potential areas of need and for anticipating how the proposed LPG project may influence household welfare, energy transition patterns, and overall social development within the community.

Table 4.16: Household Infrastructure in the Project Community

	The pie chart reveals that **firewood (50%)** is the dominant cooking energy source, followed by **charcoal (20%)**, **kerosene (20%)**, and only **10% LPG usage**. This confirms heavy dependence on traditional biomass fuels, which is typical in Sokoto State. The introduction of the LPG facility will significantly enhance access to cleaner energy, thereby reducing **deforestation, indoor air pollution, and health risks** associated with smoke inhalation.

	The main sources of water are **boreholes (45%) and wells (35%)**, while **pipe-borne water accounts for only 15%**. This reflects limited access to centralized water infrastructure. The findings indicate reliance on groundwater sources, which underscores the importance of **groundwater protection measures** in the LPG project design to prevent contamination.
	Waste disposal practices are dominated by **open dumping (40%) and burning (30%)**, with only **20% using organized collection systems**. This indicates poor waste management practices in the area. The LPG project should therefore incorporate **structured waste management systems** and possibly contribute to improving environmental sanitation awareness within the host community.
	The main power source is **generators (50%)**, followed by **grid electricity (20%)**, **solar (10%)**, and **no access (20%)**. This indicates unreliable electricity supply in the area. The LPG project may indirectly support energy diversification and economic activities requiring stable power.

	Most households use **pit latrines (60%)**, while **25% use water closets**, and **15% practice open defecation**. This reflects moderate sanitation challenges. The project should promote **improved sanitation awareness** as part of its corporate social responsibility.

4.11.6 Community Structure

4.11.6.1 Leadership, Women, and Politics

Birnin Kebbi Road, being a significant settlement within Bodinga Local Government Area, is governed under the traditional Hausa emirate system. The Sultan serves as the highest traditional authority, while the community is led locally by a District Head (Hakimi) and a Village Head (Dagaci). Subordinate leadership structures include the Ward or Clan Head (Mai Unguwa) and the Family Head (Mai Gida). Women in Birnin Kebbi Road actively participate in community affairs and contribute to peace building initiatives, highlighting their important role in social cohesion and local decision-making.

4.11.6.2 Ethnic and Religious Composition

The population of Birnin Kebbi Road is predominantly Hausa-Fulani, with a few non-indigenous residents and seasonal visitors. Hausa is the primary language spoken and understood throughout the community. Islam is the dominant religion, representing over 99% of the population, reflecting the cultural and religious homogeneity of the area.

4.11.6.3 Conflict Resolution

Conflicts in Birnin Kebbi Road are generally personal rather than between clans or groups. Disputes are encouraged to be resolved through dialogue; unresolved cases are escalated to the Village Head or, in extreme circumstances, to the District Head. Engagement with law

enforcement occurs only when sanctioned by traditional authorities, ensuring that local customs and leadership channels guide conflict resolution.

4.11.6.4 Cultural Heritage

The community does not possess any sacred sites, artefacts, or culturally significant animals within or near the proposed LPG project site. There is no record of heritage structures that would be affected by project activities, simplifying cultural impact considerations during project planning.

4.11.6.5 Relationship with Visitors

Birnin Kebbi Road residents have historically maintained cordial relationships with visitors and non-indigenous residents. The community is known for its peaceful coexistence, which has contributed to stable social relations and minimal social tension, an important factor for successful stakeholder engagement during the LPG project.

4.11.6.6 Common Crops Farmed

Agriculture remains a key livelihood activity in Birnin Kebbi Road. Residents practice subsistence and small-scale farming, cultivating crops such as maize, millet, sorghum, rice, and soya beans. Livestock farming is also prevalent, with households raising cattle, goats, sheep, and poultry (chickens, ducks, and geese). These practices indicate potential exposure to zoonotic diseases, which should be considered in environmental and health management plans for the LPG project.

4.11.6.7 Wildlife within the Community

Local fauna includes reptiles (snakes and monitor lizards), birds (Aves), and rodents. However, their populations have declined over time due to land clearance for agriculture, settlement expansion, and other anthropogenic activities. This reduction underscores the need for environmental management measures to minimize further habitat disturbance during project construction.

4.11.6.8 Vulnerable Groups

Certain population groups in Birnin Kebbi Road are more susceptible to adverse effects of the LPG project. These include women, elderly residents (60 years and above), orphans, persons with

physical disabilities, and economically disadvantaged households. Mitigation strategies should specifically address these groups to ensure equitable compensation, livelihood restoration, and access to project benefits

4.11.7 Prevalent Diseases in Birnin Kebbi Road Community

The prevalent health conditions reported within the host community are illustrated in the corresponding figure. The findings indicate that malaria accounts for the highest proportion of reported illnesses (50%), followed by typhoid fever (20%) and respiratory-related diseases (20%). This distribution reflects the typical disease pattern in Sokoto State and similar semi-arid environments, where climatic conditions such as high temperature and seasonal water stagnation promote mosquito breeding and increase malaria incidence.

Malaria remains endemic in the area and continues to have significant implications for productivity and household wellbeing, as affected individuals often lose valuable working days during periods of illness and recovery. Information obtained from local health personnel and community respondents further confirms that malaria and typhoid are the most frequently occurring ailments, particularly among vulnerable groups such as women and children.

In addition, discussions with community members revealed the presence of respiratory conditions, which may be linked to prolonged exposure to smoke from the use of firewood and other traditional biomass fuels for cooking. This observation highlights the importance of cleaner energy alternatives such as LPG, which have the potential to significantly reduce indoor air pollution, improve respiratory health, and enhance overall living conditions within the community.

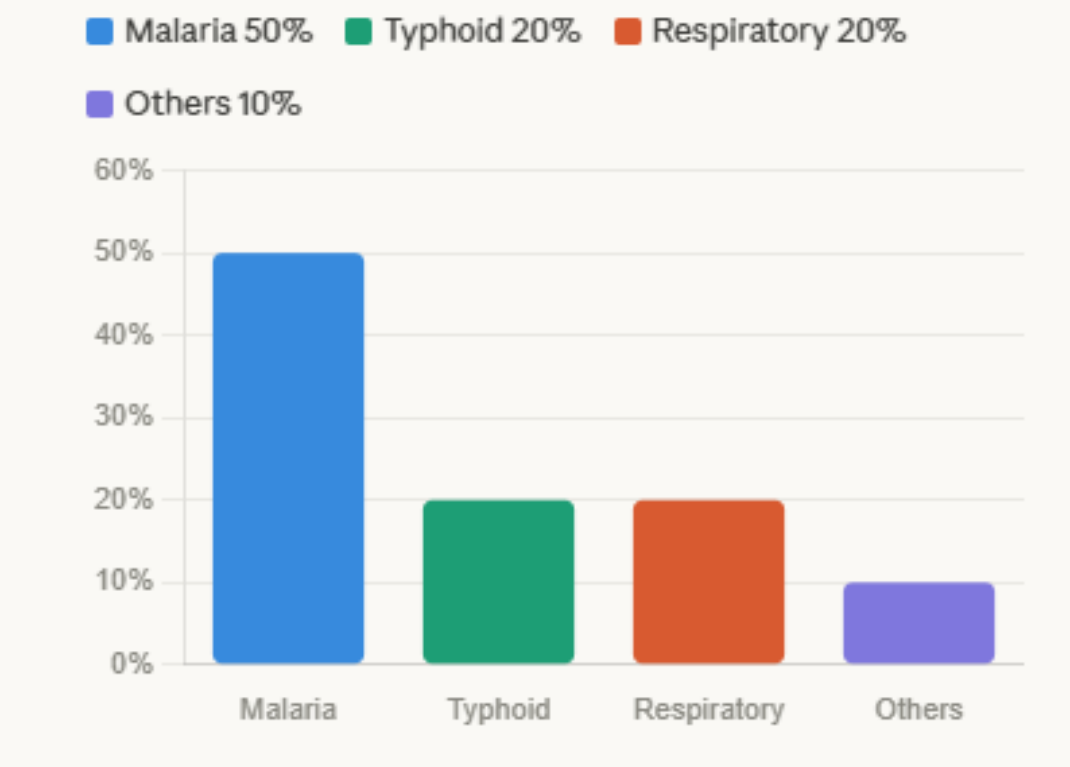


Figure 4.5: Prevalent Diseases in Birnin Kebbi Road Community

4.11.8 Transport Services in Birnin Kebbi Road Community

Road transportation constitutes the primary means of movement within Bodinga LGA and its surrounding communities. The survey identified three main modes of transport used by residents. Motorcycles represent the most widely used option, accounting for about **55%** of responses, largely due to their affordability, flexibility, and ability to navigate both paved and unpaved routes. Cars constitute approximately **20%**, serving longer-distance travel and commercial purposes, while tricycles account for about **15%**, providing intermediate transport services within and around the community.

This distribution reflects a typical semi-urban mobility structure, where informal and low-capacity transport systems dominate. The heavy reliance on motorcycles, in particular, has important safety implications. With the anticipated increase in vehicular movement associated with the proposed LPG facility—especially from delivery trucks and customer traffic—there is a need to incorporate adequate road safety measures. These should include proper traffic management, speed control

mechanisms, clear signage, and designated entry and exit points to minimize risks, particularly for motorcycle users who are more vulnerable to road accidents.

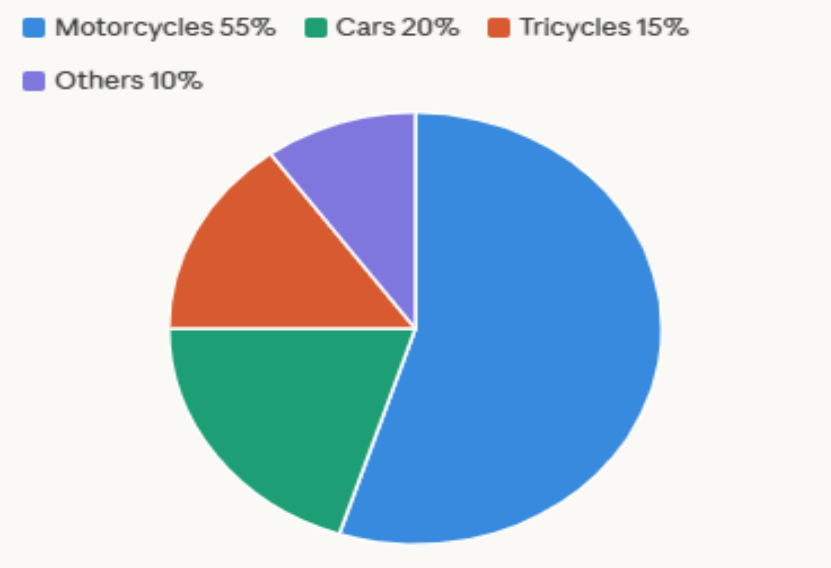


Figure 4.6: Mode of Transport in the Project Community

4.11.9 Project Impacts

4.11.9.1 Community Awareness

The chart (Figure 4.7) indicates that approximately 60% of respondents are aware of the proposed LPG project, while the remaining 40% are not aware. This suggests a moderate level of awareness within the host community, implying that initial information dissemination and stakeholder interactions have reached a fair proportion of residents.

However, the relatively high percentage of respondents who are not aware of the project highlights the need for intensified community engagement efforts. Continuous sensitization through meetings, public awareness campaigns, and consultations with community leaders will be necessary to ensure that all stakeholders are adequately informed.

Enhancing awareness will not only improve transparency but also help to address concerns, minimize misconceptions, and foster stronger community acceptance and participation, which are essential for the smooth implementation and long-term sustainability of the proposed LPG project.

Understanding these local transport dynamics is essential for effective project planning, ensuring efficient logistics, safe movement of materials, and improved accessibility for staff, customers, and service providers throughout the project lifecycle.

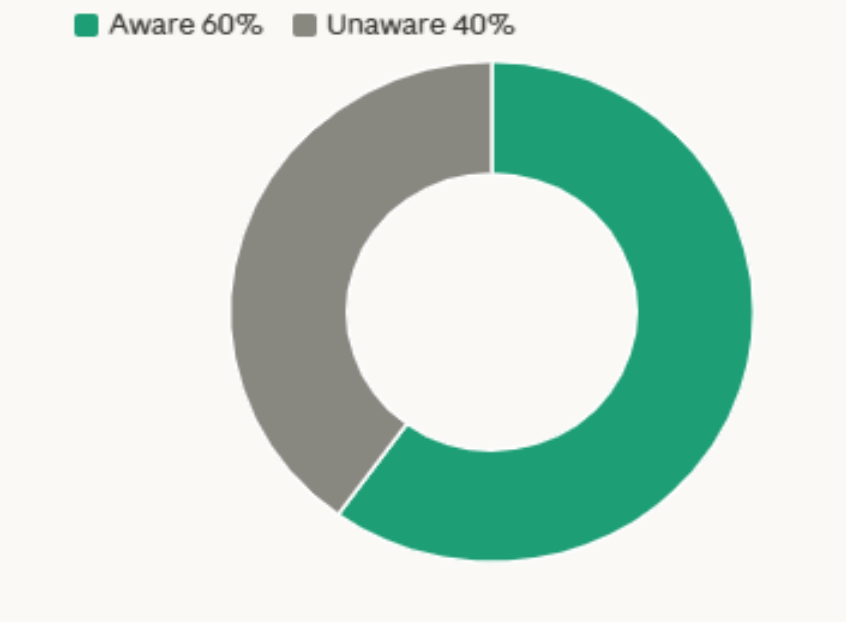


Figure 4.7: Community Awareness of the Project

4.11.9.2 Project Implication on Livelihood

The pie chart (Figure 4.8) shows that a significant proportion of respondents (**65%**) expect the proposed LPG project to have a positive influence on their livelihoods. This positive outlook is largely driven by anticipated benefits such as employment opportunities, increased commercial activities, and overall economic stimulation within the community during both construction and operational phases.

On the other hand, about **15%** of respondents expressed concerns over potential negative impacts, including possible disruptions to existing livelihood activities such as petty trading, farming, or movement within the area. Meanwhile, **20%** of the respondents indicated that the project may not have any noticeable effect on their current means of livelihood.

Overall, the findings reflect a high level of community support for the project, given its perceived economic advantages. Nonetheless, it is important for the project proponent to adopt inclusive

strategies, ensure fair access to employment opportunities, and implement appropriate mitigation measures to address concerns and maximize the positive socio-economic outcomes of the project.

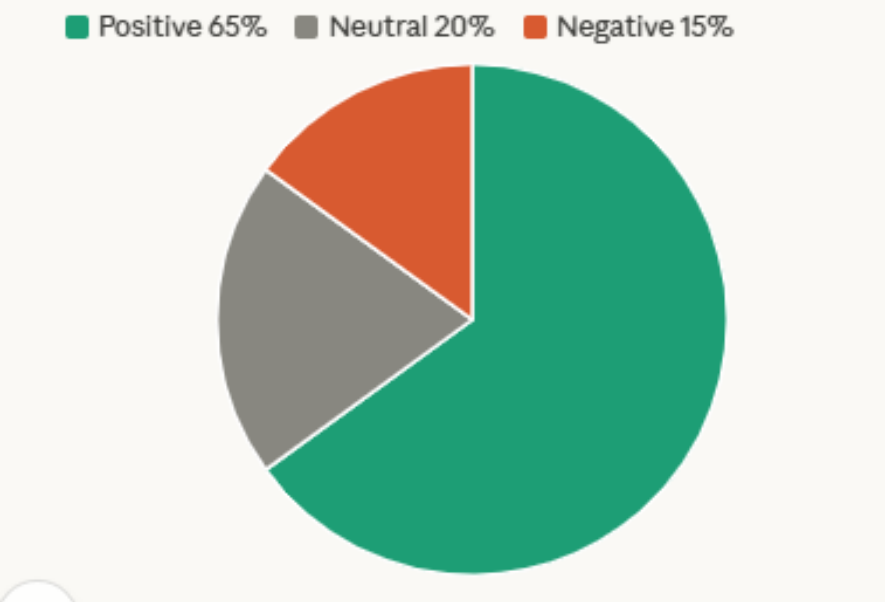


Figure 4.8: Project Implication on Livelihood

4.11.9.3 Project Implication on Cultural Interference

The chart (Figure 4.9) reveals that about 50% of respondents are of the opinion that the proposed LPG project will not have any effect on existing cultural practices within Birnin Kebbi Road and its environs. In contrast, 30% of respondents anticipate slight interference, while 20% express concerns about possible cultural disruptions.

The general perception that the project will not significantly affect cultural values suggests a high level of social acceptability, particularly as there are no known sacred sites or culturally sensitive landmarks within the immediate project area. Nonetheless, the concerns raised by a segment of the population may be linked to the anticipated influx of workers, increased human activity, and possible changes in local social interactions during the construction and operational phases.

To ensure sustained community support and cultural harmony, it is important for the project to incorporate culturally sensitive practices. This includes maintaining respect for religious norms, engaging traditional and community leaders, and ensuring that project activities align with local customs and values throughout the project lifecycle

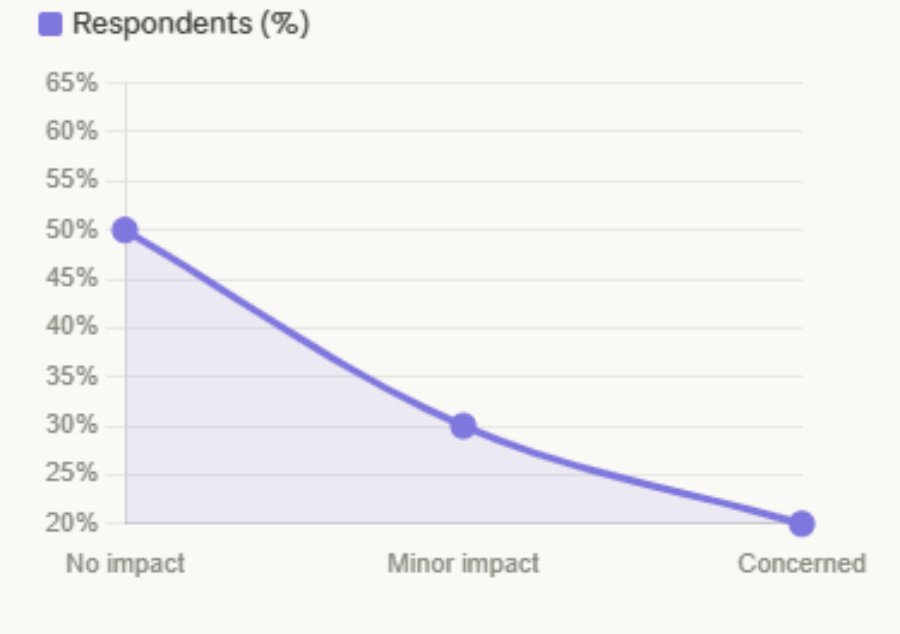


Figure 4.9: Project Implication on Cultural Interference

4.11.9.4 Expected Project Benefit

The chart (Figure 4.10) illustrates the key benefits expected by residents from the proposed LPG project in Birnin Kebbi Road. The findings show that employment opportunities (35%) constitute the most anticipated benefit, reflecting strong community expectations for job creation during both the construction and operational phases of the project.

This is followed by improved energy access (30%), indicating the community's desire for more reliable and cleaner cooking fuel as an alternative to traditional biomass sources. Business growth (20%) was also identified as a notable benefit, as the project is expected to stimulate local

economic activities, including trading, transportation, and related services. Additionally, infrastructure development (15%), such as improved road conditions and enhanced commercial facilities, was highlighted by respondents.

Overall, these responses demonstrate that the community perceives the project as a driver of economic development and improved living standards. However, meeting these expectations will require deliberate efforts by the project proponent to ensure inclusive employment, support for local enterprises, and the provision of tangible socio-economic benefits throughout the project lifecycle.

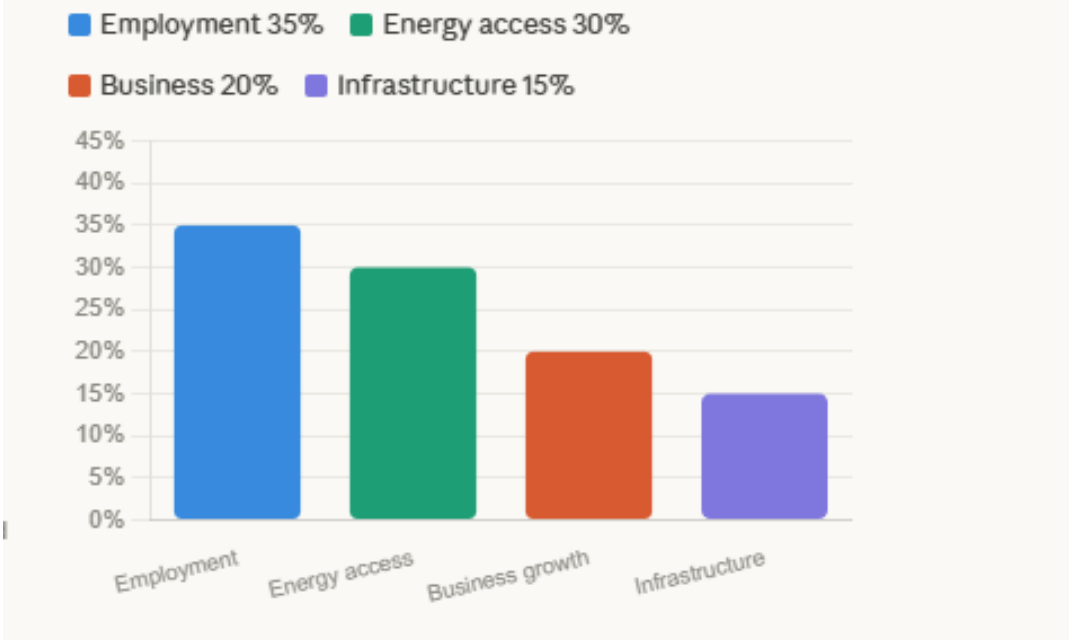


Figure 4.10: Expected Project Benefit

4.12 FOCUS GROUP DISCUSSION

A community-focused project should create opportunities that encourage the active participation of all groups within the community in order to promote collective commitment toward sustainable development. During the social assessment, Focus Group Discussions (FGDs) were conducted

with various social groups in the project area, including men, women, and youths. The views and perceptions of each group were recorded and are summarized in Table 4.17.

Table 4.17: Summary of FGD

S/N	Stakeholder Group	Main Livelihood Activities	Key Expectations	Major Concerns	EIA Team Response
1	**Adult Male Group**	Predominantly involved in crop cultivation, livestock keeping, commercial motorcycle operations, small retail businesses, masonry, and public/private employment. Some also engage in transportation and informal sector services.	Anticipation of stable income opportunities through direct and indirect employment, inclusion of local businesses in supply chains, improvement in road accessibility, and enhancement of basic infrastructure such as electricity and water supply.	General awareness of the project exists, with positive reception due to expected economic benefits. However, concerns were raised regarding operational hazards such as accidental gas discharge, fire incidents, increased heavy-duty traffic, and possible environmental disturbances.	The EIA team clarified that the facility will be designed in accordance with established safety codes, including installation of modern fire suppression systems, hazard control mechanisms, and routine safety inspections. The project will adopt local content policies to ensure participation of qualified community members, while environmental safeguards will be strictly implemented.
2	**Women Group**	Mainly engaged in food vending, grain trading, local processing activities, tailoring, and small household enterprises. Some also participate in backyard animal rearing and informal savings groups.	Desire for improved household welfare through better access to clean cooking energy, inclusion in livelihood support initiatives, improved healthcare access, and participation in community development programs.	Awareness level is moderate, with general acceptance of the project. Concerns include child safety, possible environmental noise, rising living costs, and social changes due to the presence of external workers.	The EIA team emphasized inclusive stakeholder engagement, ensuring that women are actively involved in consultation processes. It was also noted that safety education campaigns and community-based awareness programs will be implemented. Recommendations for women-focused empowerment initiatives will be incorporated into the project's social responsibility framework.
3	**Youth Group**	Youths are largely involved in informal	Strong expectation for job creation, technical	The group is generally aware and optimistic about	The EIA team assured that recruitment procedures will be

S/N	Stakeholder Group	Main Livelihood Activities	Key Expectations	Major Concerns	EIA Team Response
		employment such as motorcycle transport, skilled trades (mechanics, welding, carpentry), small-scale trading, and agricultural labour. A portion remains unemployed or underemployed.	training opportunities, skill development programs, and support for small business ventures.	the project. Key concerns include fairness in recruitment processes, limited job slots, and sustainability of employment opportunities beyond the construction phase.	transparent and merit-based, with emphasis on local participation. Provisions for vocational training and capacity building will be recommended to enhance employability. Continuous engagement with youth representatives will also be maintained to promote trust and prevent social tension.

4.13: KEY INFORMANT INTERVIEW

Key Informant Interviews (KIIs) were conducted as part of the socio-economic baseline assessment for the proposed Liquefied Petroleum Gas (LPG) project in Birnin Kebbi Road, Bodinga Local Government Area, Sokoto State. KIIs are a qualitative data collection method that involves engaging individuals with specialized knowledge, experience, or leadership roles within the community. These informants provide in-depth insights into community structure, local governance, social norms, economic activities, environmental concerns, and potential project impacts that may not be captured through household surveys or focus group discussions.

The KII participants for this study included community leaders, traditional authorities, religious leaders, heads of local associations, and other influential stakeholders. Their perspectives were crucial in understanding the prevailing social dynamics, identifying vulnerable groups, and assessing the community's expectations and concerns regarding the proposed LPG project. The information obtained from KIIs helped validate findings from other socio-economic tools and informed recommendations for effective stakeholder engagement and project impact mitigation.

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Table 4.18: Summary of Key Informant Interview

S/N	Key Informant	Position/Title	Key Issues Discussed	Major Concerns Raised	EIA Team Response
1	District Head (Hakimi)	Traditional Leader	Community governance structure, land ownership system, level of project awareness, security arrangement in the area	Safety of the LPG facility, strict compliance with traditional protocols, involvement of traditional institutions in project implementation, and employment opportunities for local indigenes	The EIA team assured that the project will comply with all national safety regulations and industry best practices. Respect for traditional authority will be maintained throughout the project lifecycle. Local labour will be prioritized in line with the local content policy.
2	Village Head (Dagaci)	Community Leader	Existing land use patterns, farming activities near the project site, cultural values and settlement structure	Possible land acquisition disputes, compensation transparency, increased traffic during construction, and temporary disturbance to farming activities	The EIA team confirmed that land acquisition followed due process and that compensation issues will be handled transparently. Traffic management measures and construction scheduling will be incorporated into the Environmental and Social Management Plan (ESMP) to minimize disruption.
3	Primary Health Officer	Health Sector Representative	Common diseases in the community, healthcare capacity, emergency preparedness, and potential public health implications of the LPG facility	Possible increase in respiratory illnesses, fire incidents, and need for emergency response preparedness	The EIA team assured that comprehensive health and safety measures will be implemented, including fire prevention systems, routine safety inspections, staff training, and integration of an Emergency Response Plan (ERP) into the ESMP.
4	Community School Headmaster	Education Representative	Youth unemployment, educational level of residents, skill gaps among youths, and infrastructure challenges	Lack of technical skills among youths, risk of exclusion from employment opportunities, and need for educational support	The EIA team recommended the inclusion of vocational training, skill acquisition programmes, and local capacity building initiatives as part of the project's Corporate Social

S/N	Key Informant	Position/Title	Key Issues Discussed	Major Concerns Raised	EIA Team Response
					Responsibility (CSR). Transparent recruitment processes will be encouraged.
5	Community Development Association (CDA) Chairman	Community Representative	Community development priorities, infrastructure deficits, social cohesion, and stakeholder engagement	Rehabilitation of access roads, improvement of potable water supply, electricity support, and transparency in employment recruitment	The EIA team assured that community concerns will be reflected in the Community Development Agreement (CDA). Continuous stakeholder engagement, grievance redress mechanisms, and infrastructure support initiatives will form part of the project implementation strategy.

CHAPTER FIVE

ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACT

5.1 INTRODUCTION

This chapter provides information on the assessment of the potential environmental and socioeconomic impacts of the proposed project. A description of the identification and evaluation methodology used to assess the significance of impacts, having taken into account impact magnitude and sensitivity of receptors and resources affected, is provided below.

5.2 METHODOLOGY FOR IMPACT IDENTIFICATION AND EVALUATION

The potential environmental and social impacts associated with the proposed LPG project in Birnin Kebbi Road, Bodinga LGA, were systematically assessed by integrating the project components with the surrounding environmental, social, and cultural settings. This section outlines the key impacts anticipated from the project and describes the approach used to assess their significance. A combination of techniques was applied, including the use of checklists, impact matrices, stakeholder consultations, and expert judgment.

The impact assessment process involved three main phases:

i. **Impact Identification:** Recognizing the possible impacts related to each stage of the LPG project activities;

ii. **Impact Prediction:** Estimating the nature, scale, duration, and reach of these impacts; and

iii. **Impact Evaluation:** Assessing the significance of these impacts by considering their magnitude and the sensitivity of affected receptors.

5.2.1 Impact Identification

Using a checklist grounded in detailed baseline data and a comprehensive understanding of Birnin Kebbi Road's local environment, potential impacts of the LPG project were identified by examining:

- The source or cause of impacts (e.g., specific project activities or environmental aspects);
- The receptors of these impacts (such as local ecosystems, water resources, and socioeconomic conditions);
- The pathways through which impacts could affect receptors; and
- The possible consequences of these impacts on the environment and community.

5.2.2 Impact Prediction

To further qualify these impacts, each was characterized according to several criteria relevant to the Birnin Kebbi Road context:

- **Beneficial Impacts:** Positive effects that improve environmental or social conditions;
- **Adverse Impacts:** Negative effects that may cause harm or disruption;
- **Direct Impacts:** Immediate effects directly linked to LPG project activities;
- **Indirect Impacts:** Secondary effects occurring later or at a distance from the project site;
- **Cumulative Impacts:** Combined impacts with other past, present, or future projects in the Birnin Kebbi Road area;
- **Reversible Impacts:** Effects from which the environment or community can recover;
- **Irreversible Impacts:** Long-lasting changes that cannot be fully undone;
- **Residual Impacts:** Remaining effects after mitigation measures have been implemented;
- **Short-term Impacts:** Temporary effects that dissipate after project phases or mitigation; and
- **Long-term Impacts:** Persistent effects lasting beyond project completion.

5.2.3 Impact Evaluation

The final phase evaluated the significance of each identified impact by assessing:

- **Duration:** Whether impacts are temporary (days to months) or permanent;

- **Extent:** The geographical reach, whether site-specific, local, or regional within Birnin Kebbi Road and its surroundings;
- **Intensity:** The severity of the impact, ranging from weak to strong based on changes to environmental or social components; and
- **Severity:** The overall importance of the impact, combining magnitude and receptor sensitivity, to prioritize mitigation and management efforts effectively.

This structured evaluation ensures that the EIA for the Birnin Kebbi Road LPG project delivers a clear understanding of risks and opportunities, guiding decision-making toward sustainable project implementation.

Table 5.1: Impact Evaluation Matrix

		Sensitivity/Vulnerability of Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

5.3 IMPACT SIGNIFICANCE CATEGORIES AND KEY ENVIRONMENTAL/SOCIOECONOMIC FACTORS

- **Major Impact:** A major impact refers to a highly significant effect where environmental standards or limits may be exceeded, or where substantial harm occurs to highly sensitive or valued resources in Birnin Kebbi Road. Such impacts are severe and difficult to mitigate, potentially causing long-lasting damage to the environment or community well-being.
- **Moderate Impact:** Moderate impacts fall within acceptable limits but may approach thresholds where harm could become more serious. These impacts are notable but can be effectively reduced through targeted mitigation measures. They represent substantial

effects on the environment or social systems of Birnin Kebbi Road but do not surpass critical levels.

- **Minor Impact:** Minor impacts cause measurable but limited effects that remain well within regulatory standards or affect resources with low sensitivity. These impacts have limited consequences and may or may not require intervention, having a generally subdued effect on the local environment or society.

5.3.1 Environmental and Socioeconomic Factors Considered

The assessment considered a wide range of environmental and social receptors potentially affected by the LPG project in Birnin Kebbi Road, including:

Biophysical Environment:

- Air quality and emissions,
- Noise and vibrations from machinery and vehicles,
- Soil and geological conditions,
- Surface and groundwater resources,
- Local ecology and biodiversity.

Socioeconomic Environment:

- Visual and aesthetic quality of the landscape,
- Effects on local communities, including cultural and social dynamics,
- Gender considerations and vulnerable groups,
- Community health, safety, and security,
- Potential resettlement needs,
- Labor and working conditions,
- Existing infrastructure capacity,
- Employment opportunities and economic impacts,
- Preservation of cultural heritage.

5.4 PROJECT ACTIVITIES BY PHASE

The LPG project activities were divided into distinct phases, each with specific anticipated actions:

Pre-Construction Phase:

- Mobilization and transportation of equipment, materials, and personnel to Birnin Kebbi Road,
- Energy provision for site preparation and initial works,
- Site clearing and land excavation,
- Recruitment and deployment of labor.

Construction Phase:

- Ongoing transportation of materials and workers,
- Excavation and foundation works,
- Construction of the LPG station platform, including fabrication and coating,
- Installation and commissioning of the gas plant equipment,
- Demobilization of the construction workforce.

Operational Phase:

- Emissions and air pollution from compressors, pumps, and generators,
- Noise and vibration impacts from operational equipment and traffic,
- Risks of soil contamination due to oil spills and equipment leaks,
- Fire hazards and disaster risk management,
- Generation of solid and liquid wastes,
- Increased demand on local social services and infrastructure,
- Potential for traffic accidents related to project activities,
- Health and safety concerns for workers and the community.

Decommissioning Phase:

- Dismantling and removal of gas plant infrastructure,

- Disposal or relocation of storage tanks and gantry equipment,
- Increased generation of solid waste requiring management.

5.5 IMPACT IDENTIFICATION AND EVALUATION PROCESS

To ensure thorough assessment in line with Environmental and Social Impact Assessment (ESIA) guidelines, the following steps were applied for the Birnin Kebbi Road LPG project:

- **Impact Identification:** Comprehensive listing of all potential biophysical, social, and health-related impacts, considering both significant and minor effects from the project phases.
- **Impact Qualification:** Characterizing the nature of each impact (positive or negative, direct or indirect).
- **Impact Rating:** Assigning a level of significance (major, moderate, or minor) based on the magnitude and sensitivity of affected resources or communities.
- **Impact Description:** Detailed explanation of how each impact arises, its consequences, and potential mitigation approaches.

This approach ensures that all relevant interactions between the LPG project activities and the Birnin Kebbi Road environment and community are accounted for, providing a clear basis for management and decision-making.

Table 5.2: Identified Proposed Project Impact

Impacts identification	Phases of the Proposed Project		
	Construction phase	Operation phase	Decommissioning phase
Alteration of soil profile	*	*	*
Change in land use	*	*	*
Change in water quality	*		*
Acceleration of erosion	*		

Acidification of soil and water	*	*	*
Alteration of local topography	*		
Blockage of roads/motorways	*		*
Damage to communication cables	*		
Burns/injuries from welding sparks	*	*	*
Exposure to heat and light	*		*
Exposure to welding flash	*	*	*
Impairment of air quality	*	*	*
Improved livelihood	*	*	*
Improved gas supply to customers		*	
Increased demand for social infrastructure	*	*	*
Increase in income	*	*	
Increase in price of locally sourced materials	*		
Increased opportunity for business and employment	*	*	*
Increase in incidence of STI's including HIV	*		*
Influx of migrant workers	*		*
Legal issues	*	*	*

5.5.2 Impact Qualification

The identified potential impacts of the LPG project in Birnin Kebbi Road were classified using four key criteria:

- Whether the impact is positive or negative,
- Whether it is short-term (lasting less than three months) or long-term (lasting longer than three months),

- Whether the impact is reversible (the environment or community can return to its original state after the impact ceases) or irreversible (permanent change or damage),
- Whether the impact is direct (occurs as an immediate result of project activities) or indirect (secondary effects that occur later or further away from the source).

Negative impacts represent harmful effects on the local biophysical environment, public health, or social conditions. Positive impacts, on the other hand, improve environmental quality or community well-being. This classification helps to better understand the nature and duration of each impact and its potential for recovery.

5.5.3 Impact Rating

To determine the overall significance of each impact, a rating system was applied using a numerical scale of 0, 1, 3, and 5, based on criteria adapted from the International Organization for Standardization (ISO) 14001 Environmental Management System framework. The criteria used for rating impacts in the Birnin Kebbi Road LPG project include:

- Legal/Regulatory Requirements (L): Whether national or local regulations (such as those from FMEnv, NMDRA, and AKSEPA) apply to the impact. Ratings reflect if there is no regulation (0), some regulation (3), or strict regulation with permits required (5).
- Risk Factor (R): Assessed using a Risk Assessment Matrix (RAM) that combines the probability of impact occurrence with the severity of its consequences. Risks are categorized as low (1, green), intermediate (3, yellow), or high (5, red).
- Frequency (F): How often the impact is likely to occur, informed by historical data, expert input, and community consultations.

- Importance (I): The value or sensitivity of the environmental or social component affected, determined through stakeholder engagement and expert consensus.
- Public Perception (P): The level of concern or support expressed by the community and other stakeholders regarding the impact.

The combined weighting of these five factors generates an overall significance score for each impact. This scoring system helps prioritize which impacts require urgent mitigation and management during the implementation of the LPG project in Birnin Kebbi Road.

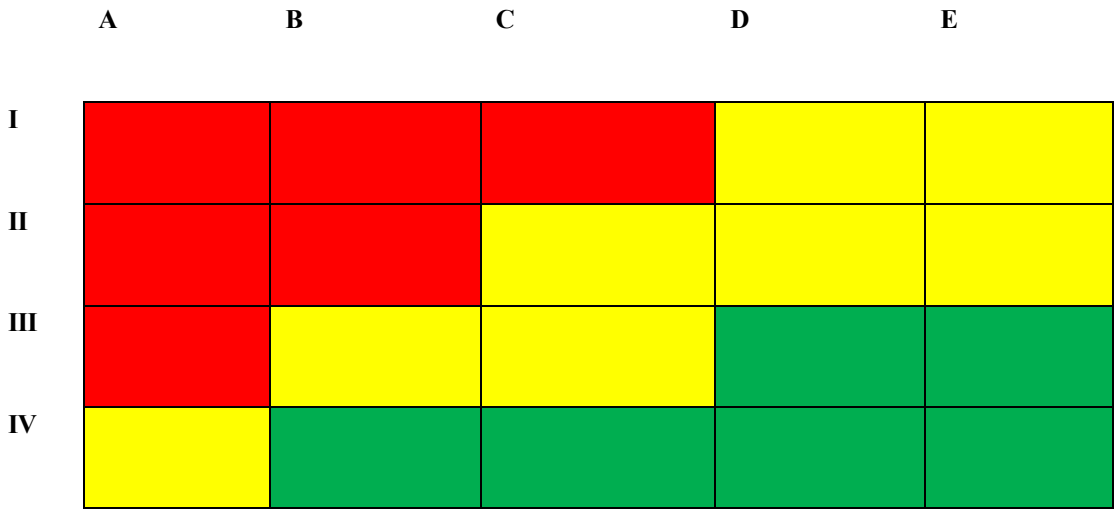

Figure 5.1: Risk Assessment Matrix

NOTE: Where 1=Low risk (green), 3=Intermediate risk (yellow) and 5=High risk (red)

Table 5.3: Impact Value and Rating Colour Code

Impact value	Cut off values	Impact Rating
L+R+F+I+P	<8	Low

L+R+F+I+P	≥8 but <15	Medium
L+R+F+I+P	≥15	High
F + I	>6	High
P	= 5	High
Positive		positive

Note: L= Legal/Regulatory, R = Risk, F= Frequency, I = Importance, P = Public Interest/ Perception

Table 5.5: Potential and Associated Impacts of the Proposed Project (Pre-Construction Phase)

S/N	Project Activities	Impact Description	Impact Rating	Positive	Negative	Direct	Indirect	Short Term	Long Term	Reversible	Irreversible	L	R	F	I	P	Total
1	Land Acquisition	Loss of land and displacement of land users	H		√	√			√		√	5	5	5	5	5	25
2	Land Acquisition	Loss of livelihood for informal land users and subsistence farmers	H		√	√			√		√	5	4	4	4	5	22
3	Land Acquisition	Third-party agitation due to compensation concerns	H		√	√		√		√		4	4	3	3	4	18
4	Community Sensitization	Raised expectations or exclusion of vulnerable groups	M		√	√		√		√		3	3	2	2	2	12
5	Site Survey and Soil Investigation	Temporary soil compaction and vegetation disturbance	L		√	√		√		√		2	1	1	1	2	7
6	Mobilization of Equipment and Personnel	Traffic congestion and road safety risks	M		√	√		√		√		3	3	2	2	3	13
7	Mobilization of Equipment and Personnel	Noise and short-term emissions from vehicles	M		√	√		√		√		2	2	2	2	2	10
8	Influx of Job Seekers	Strain on local infrastructure and housing	M		√		√	√		√		3	3	2	3	3	14

S/N	Project Activities	Impact Description	Impact Rating	Positive	Negative	Direct	Indirect	Short Term	Long Term	Reversible	Irreversible	L	R	F	I	P	Total
9	Influx of Job Seekers	Social tension between indigenes and migrants	H		√		√	√		√		4	3	2	3	4	16
10	Site Clearing and Bush Removal	Loss of biodiversity and natural habitat	H		√	√		√			√	5	5	5	5	5	25
11	Site Clearing and Bush Removal	Erosion risk due to vegetation loss	H		√	√		√			√	5	5	4	4	4	22
12	Initial Waste Generation	Uncontrolled disposal of vegetation and domestic waste	M		√	√		√		√		3	2	2	2	2	11
13	Initial Waste Generation	Visual nuisance from unmanaged site debris	L		√	√		√		√		2	1	1	1	1	6

Note: L= Legal/Regulatory, R = Risk, F= Frequency, I = Importance, P = Public Interest/ Perception

Table 5.6: Potential and Associated Impacts of the Proposed Project (Construction Phase)

S/N	Project Activities	Impact Description	Impact Rating	Pos	Neg	Dir	Ind	ST	LT	Rev	Irrev	L	R	F	I	P	Total
1	Civil Works (Buildings, Drainage, Roads)	Soil disturbance and erosion from excavation activities	H		√	√		√			√	4	4	4	4	4	20
2	Civil Works	Generation of construction waste (debris, packaging)	M		√	√		√		√		3	2	2	2	2	11
3	Installation of LPG Tanks	Risk of accidents due to lifting and confined space works	H		√	√		√			√	5	4	4	4	4	21

S/N	Project Activities	Impact Description	Impact Rating	Pos	Neg	Dir	Ind	ST	LT	Rev	Irrev	L	R	F	I	P	Total
4	Installation of Pumps & Compressors	Noise from mechanical fittings, hearing damage risk	H		√	√		√	√			3	3	3	3	3	15
5	LPG Piping and Valve welding	Gas exposure, inhalation or pressure injuries	H		√	√		√		√		5	5	4	4	4	22
6	Fire Hydrant and Safety Systems	welding noise and minor emissions	L		√	√		√	√			2	1	2	1	1	7
7	Electrical Installation	Electrocution or fire hazard during testing	H		√	√		√		√		3	4	3	3	3	16
8	Hydrotesting Pipelines and Tanks	Contamination from hydrotest water and chemical additives	M		√	√		√	√			3	3	3	3	2	14
9	Operation of Generators and Equipment	Air pollution (NOx, CO), noise impact on nearby receptors	H		√	√		√		√		5	4	5	5	4	23
10	General Construction Activities	Risk of injury (falls, slips, equipment impact) to workers and passersby	H		√	√		√		√		5	5	4	5	4	23

Note: L= Legal/Regulatory, R = Risk, F= Frequency, I = Importance, P = Public Interest/ Perception

Table 5.7: Potential and Associated Impact of the Proposed Project (Operation Phase)

Project activities	Impact description	Impact Rating	Impact Qualification								Impact Quantification					Total
			Positive	Negative	Direct	Indirect	Short term	long Term	Reversible	Irreversible	L	R	F	I	P	
Plant operation/maintenance	Air pollution from gas plant facilities	H		√	√			√		√	0	5	5	5	3	18
	Noise and vibration from compressors, pumps, generators, vehicles etc	H		√	√		√		√		3	3	3	3	3	15
	Contamination of land; due to equipment and machinery oil spills and leakages	H		√	√			√	√		5	3	3	5	1	17
	Fire risks/explosion	M		√	√			√	√		3	5	1	1	3	13
	Increased solid and liquid waste generation	M									1	3	3	3	3	13
	Pressure on social amenities	L		√	√		√		√			1	1	3	1	6
	Traffic accident	M		√	√			√		√		3	3	3	3	13
	Health and Safety	H		√			√	√		√	3	3	3	3	3	15

Table 5.8: Potential and Associated Impact of the Proposed Project (Decommissioning Phase)

Project activities	Impact description	Impact Rating	Impact Qualification								Impact Quantification					Total
			Positive	Negative	Direct	Indirect	Short term	long Term	Reversible	Irreversible	L	R	F	I	P	
Dismantling of the gas plant	Noise and vibration	M		√	√		√		√			3	3	1	1	8
	Impairment of air quality	M		√	√	√	√		√			3	3	1	3	10
	Solid waste generation and impact on disposal facility	M		√	√	√	√		√			3	3	3	3	12
	Loss of job	H		√	√			√		√		5	5	5	5	20
	Revegetation	P	√		√				√							

5.6 EVALUATION OF POTENTIAL IMPACTS OF THE PROPOSED PROJECT

5.6.1 Potential Positive Environmental and Social Impact

The proposed LPG project in Birnin Kebbi Road, Bodinga LGA, is expected to generate several positive impacts, which are summarized and assessed in Table 5.9 of the report. These benefits include:

- Enhanced availability and distribution of cleaner fuel alternatives like LPG, supporting energy diversification in the region.
- Boosting the local rural economy and contributing to broader national economic growth through increased energy access and business activities.
- Creation of job opportunities for residents of Birnin Kebbi Road and neighboring communities, which will support livelihoods.
- Development and improvement of local infrastructure, facilitating better services and connectivity.
- Targeted employment prospects for youth and women, promoting inclusive economic participation.
- Increased income levels and improved living standards for the host community as a direct result of the project.
- Strengthening the financial capacity of local institutions and regulatory agencies through expanded revenue streams related to the project.

Table 5.9: Evaluation of Potential Positive Impact

S/N	Potential Impact	Key Receptors	Evaluation	Significance
1	Improved LPG product demand and supply	community	Improved supply of gas product will bridge the gap in demand of LPG product. The magnitude is medium and the sensitivity is high. The proposed project will have a positive impact on community business security. This combined with improved access to markets will help local business men and women to make better decisions that will increase their income variability.	Major

3	Elevation of rural income and national economy ;	Farmers, Neighbouring communities, state and national economy	The local and national economy will be boosted through the following: • direct and indirect job creation; • increased income for workers; • increase in business activities in the communities; • increased LPG product will reduce cost; • Payment of taxes will improve the revenue base of the economy. The impact will be regional and permanent, lasting throughout the duration of the project. The magnitude is large and the Sensitivity is high.	Major

4	Employment creation for community members;	Community members, people from other communities	The proposed project will result in the engagement of skilled and unskilled labour for the planning, construction, operation, maintenance phases of the project. The project will therefore have a major positive impact on the socioeconomic conditions of the local communities in and around the project area as a whole through the creation of permanent and temporary direct jobs as well as indirect jobs. The magnitude islarge and the sensitivity is high.	Major
5	Improved infrastructure;	community	The proposed project in improving infrastructure will have socio-economic benefits which includesthe all-weather road reducing transportation costs, increased access to markets for local produce and products, better access to health care and other social services. In the long term, this will have more positive benefits to local economicdevelopment. The impact will be major and of regional extent. The magnitude is large and the sensitivity is high	Major
6	Employment generation for youth and women;	Neighbouring community	It is anticipated that some percent of the totaldirect labour during pre and construction workers will be youth and women. The impact will be major and of regional extent. The magnitude is large and the sensitivity is high	Major

7	Enhanced income and livelihoods of member of the host community;	Community members	The implementation of the project will inspirecommercial activity in the project area and also provide direct and indirect jobs. The impact on out growers and other workers' incomes and livelihoods will be major and permanent. The magnitude is large and the sensitivity is high	Major
8	Improvement in the revenue base of key institutions and regulatory bodies	Neighbouring Communities, local government, state and national economy	Revenue will accrue to traditional authorities and regulatory institutions through the payment of royalties and regulatory fees and levies. The impact will be permanent, lasting throughout the duration of the project. The impact will be permanent, lasting throughout the duration of the project. The magnitude is large and the sensitivityis Medium	Major

5.6.2 Discussion of Potential Impact

Environmental and Social Impacts of the Pre-Construction Phase

The pre-construction phase of the proposed LPG project in Birnin Kebbi Road, Bodinga Local Government Area, involves preparatory activities such as land acquisition, site clearing, grading, and establishment of temporary facilities, mobilization of equipment and personnel, and preliminary environmental and geotechnical investigations. Although this phase is relatively short-term, it presents both positive and negative environmental and social implications for the host community.

On the positive side, the commencement of pre-construction activities signals the beginning of economic engagement in Birnin Kebbi Road. Local residents may be employed for site clearing, manual excavation, security, and other support services, providing short-term income opportunities, particularly for unskilled and semi-skilled youth. These activities can stimulate the local economy through increased demand for food, water, transportation, and other basic services. Small-scale traders, food vendors, and motorcycle operators are also likely to benefit indirectly. In addition, early visibility of the project may generate optimism within the community, especially regarding expectations of longer-term employment, infrastructure improvement, and corporate social responsibility initiatives associated with the LPG facility.

Conversely, pre-construction activities may result in environmental disturbances, particularly vegetation removal and land surface alteration due to site clearing and grading. Although Birnin Kebbi Road is largely agrarian and already subject to human activities, excessive clearing of

grasses and shrubs could expose soils to erosion, especially during the rainy season. This may affect natural drainage patterns and increase sediment runoff into nearby low-lying areas. Equipment mobilization and site preparation activities may also generate temporary dust, noise, and vibration, which could affect air quality and cause nuisance to nearby households.

From a social perspective, land acquisition and restriction of access to communal resources may trigger grievances if not properly managed. Inadequate consultation, unclear compensation arrangements, or poor communication could lead to community dissatisfaction or disputes. Temporary loss of access to farmlands, footpaths, or water sources may particularly affect vulnerable groups such as women and subsistence farmers. In addition, the presence of non-local workers, even at this early stage, may place pressure on local facilities or create social tension if cultural norms and traditional authority structures in Birnin Kebbi Road are not respected.

Overall, while the pre-construction phase of the proposed LPG project in Birnin Kebbi Road offers early economic benefits, it also presents manageable environmental and social risks. These risks can be minimized through effective stakeholder engagement, transparent land acquisition processes, proper documentation of grievances, and early implementation of environmental control measures such as dust suppression and erosion prevention.

Environmental and Social Impacts of the Construction Phase

The construction phase of the proposed LPG facility in Birnin Kebbi Road, Bodinga LGA, involves major civil and mechanical works, including excavation, foundation construction, installation of gas processing and storage equipment, construction of access roads, and erection of administrative and support structures. This phase is critical to project development and is associated with both significant benefits and potential adverse impacts.

In socio-economic terms, the construction phase is expected to generate notable employment opportunities for residents of Birnin Kebbi Road and surrounding communities. Both skilled and unskilled labour will be required, offering short- to medium-term income generation for local youth and artisans. Indirect economic benefits are also anticipated through increased demand for transport services, catering, accommodation, and petty trading. The use of local suppliers for construction materials and services, where feasible, will further enhance income circulation within

the local economy. Visible progress of the project may also strengthen community confidence in the anticipated benefits of the LPG development.

However, construction activities may give rise to several environmental impacts. Earthworks and movement of heavy machinery can lead to soil compaction, erosion, and surface runoff if not properly controlled. Dust emissions from excavation, material handling, and vehicular traffic may temporarily degrade air quality, while exhaust emissions from machinery and generators may contribute to localized pollution. Noise and vibration from construction equipment could disturb nearby households and sensitive receptors, particularly during peak construction periods.

Improper handling of construction waste, including concrete debris, metal scraps, packaging materials, and waste oils, may result in land contamination if adequate waste management measures are not enforced. There is also a risk of accidental fuel or lubricant spills, which could affect soil and shallow groundwater. Limited vegetation removal during construction may reduce natural ground cover and increase vulnerability to erosion.

Social impacts during construction may include increased pressure on local infrastructure and services due to the presence of construction workers. Movement of heavy trucks along local roads may increase the risk of traffic accidents, affecting farmers, traders, and schoolchildren. Temporary disruption of community activities, noise during prayer periods, or obstruction of access routes could also generate community concerns. If employment expectations are not well managed or if vulnerable groups are excluded from opportunities, perceptions of inequality may arise.

In summary, the construction phase of the proposed LPG project in Birnin Kebbi Road is expected to deliver important socio-economic benefits, particularly in terms of employment and local economic stimulation. Nevertheless, it also poses environmental and social risks related to air quality, noise, waste generation, land disturbance, and community relations. These impacts can be effectively managed through the implementation of appropriate environmental mitigation measures, strict health and safety protocols, traffic management plans, local employment policies, and continuous community engagement to ensure environmental protection and social acceptance throughout the construction period.

Environmental and Social Impacts during Commissioning, Operation, and Maintenance Phase

The commissioning, operation, and maintenance (O&M) phase of the proposed LPG facility in Birnin Kebbi Road, Bodinga LGA, represents the transition from construction activities to full operational status. This phase includes equipment testing and calibration, routine operations such as receipt, compression, storage, and dispensing of Liquefied Petroleum Gas, as well as periodic maintenance of mechanical, electrical, and civil installations. While this phase is essential for the long-term functionality and economic sustainability of the project, it is associated with a range of environmental and social impacts that require careful management.

On the positive side, the operational phase of the LPG project is expected to enhance access to cleaner and more affordable energy within Bodinga LGA and surrounding areas. The availability of LPG provides an alternative to conventional fossil fuels and biomass, supporting Nigeria's energy transition agenda and efforts to reduce greenhouse gas emissions. Increased use of LPG, particularly in transportation and small-scale commercial activities, can contribute to improved air quality and reduced reliance on firewood and diesel, with attendant public health benefits. Improved energy access may also support local economic activities and enhance productivity among small businesses and transport operators.

Socioeconomically, this phase will provide relatively stable employment opportunities for technical staff, plant operators, safety personnel, security staff, and administrative workers. Where local recruitment is prioritized, the project can contribute to reducing unemployment and improving household incomes in Birnin Kebbi Road and neighbouring communities. Additional indirect employment opportunities are expected through associated services such as gas haulage, vehicle maintenance, retail distribution, and support services. Furthermore, the project proponent's Corporate Social Responsibility (CSR) initiatives may contribute to improvements in local infrastructure and social services, thereby strengthening community–project relations.

However, the operation and maintenance phase also presents potential adverse environmental and social risks. The handling and storage of pressurized natural gas pose inherent safety hazards, including the risk of gas leaks, fire outbreaks, or explosions in the event of equipment failure or human error. Such incidents could have serious consequences for workers and nearby residents if

not adequately controlled. Fugitive emissions from routine operations may also contribute marginally to greenhouse gas emissions.

Air quality impacts may arise from increased vehicular traffic associated with gas transportation and facility operations. Emissions from trucks, particularly during idling and loading activities, could affect ambient air quality in the immediate vicinity of the facility. Increased traffic movement along access roads may also elevate the risk of road accidents involving pedestrians, cyclists, and other road users. Noise and vibration generated from compressors, generators, and loading activities—especially during extended or nighttime operations—may cause disturbance to nearby settlements if not properly mitigated.

Social concerns may emerge if community expectations regarding employment opportunities, environmental protection, or CSR commitments are not adequately managed. Inadequate sensitization of residents on safety issues related to LPG operations could lead to fear, misinformation, or panic during routine operations or emergency drills. Maintenance activities involving oils, lubricants, and other hazardous materials may also result in soil or water contamination if waste handling procedures are not strictly enforced. In addition, excessive water use for cleaning and cooling purposes could place pressure on local water resources, particularly during the dry season.

To ensure sustainability during the O&M phase, a comprehensive Safety Management Plan (SMP) should be implemented, incorporating regular inspections, preventive maintenance, emergency preparedness, and staff training. Environmental Management Plans (EMP) should address emissions control, noise reduction, waste management, and water conservation. Continuous stakeholder engagement, effective grievance redress mechanisms, and risk communication strategies will be essential in maintaining community trust and ensuring compliance with regulatory requirements.

Environmental and Social Impacts during the Decommissioning Phase

The decommissioning phase of the proposed LPG facility in Birnin Kebbi Road marks the end of the project's operational life and involves dismantling, removal, and safe disposal of all project-related infrastructure and equipment. Although this phase is generally short-term, it carries

important environmental and social implications that must be carefully managed to prevent long-term adverse effects.

Positively, decommissioning provides an opportunity for site restoration and environmental remediation. Proper removal of equipment and rehabilitation of disturbed areas can restore the land to its original or an improved condition. Soil remediation and re-vegetation efforts can support the recovery of local ecosystems and enable the land to be reused for agriculture, community infrastructure, or other development purposes relevant to Birnin Kebbi Road and Bodinga LGA. The removal of a gas facility also reduces long-term safety risks associated with pressurized gas storage.

Social benefits may include short-term employment opportunities for local workers engaged in dismantling, waste handling, and site rehabilitation activities. Additionally, the vacated land may be repurposed for alternative community or government development projects, potentially generating new economic or social benefits. The removal of the facility may also alleviate long-term safety concerns among nearby residents.

Despite these benefits, decommissioning activities may pose environmental risks if not properly managed. Residual gases, oils, lubricants, and other hazardous materials may contaminate soil or water resources if released during dismantling. Demolition activities may generate dust, noise, and air emissions, particularly where heavy machinery is used. The dismantling of pressurized pipelines and storage systems also presents significant safety risks, including the possibility of gas leaks or explosions if procedures are not strictly followed.

Socially, the closure of the facility may lead to job losses for workers employed during the operational phase, resulting in short-term economic hardship for affected households. Communities that have developed economic linkages with the project, such as through ancillary businesses or service provision, may experience a temporary decline in income. Additionally, withdrawal of CSR support previously provided by the project proponent—such as assistance to schools, health facilities, or community infrastructure—may create service gaps if not adequately transitioned.

To manage these impacts, a detailed Decommissioning and Site Closure Plan (DSCP) should be developed prior to project shutdown. This plan should include procedures for safe dismantling, hazardous waste management, environmental remediation, and post-closure monitoring. Community consultations should be conducted to manage expectations, communicate timelines, and discuss future land-use options. Measures to support workforce transition and mitigate socio-economic impacts of job losses should also be considered.

In conclusion, while the decommissioning of the proposed LPG facility in Birnin Kebbi Road has the potential to eliminate long-term operational risks and restore the local environment, it must be implemented with the same level of planning, regulatory compliance, and stakeholder engagement as other project phases. With appropriate mitigation measures, decommissioning impacts can be minimized and transformed into opportunities for sustainable land use and community development.

5.6.3 Residual Environmental and Social Impacts of the Project

Residual environmental and social impacts are those effects that remain after the full implementation of mitigation and management measures across all phases of a project. Although the proposed LPG facility in Birnin Kebbi Road will adopt industry best practices, regulatory compliance, and proactive mitigation strategies, certain impacts may persist due to the inherent nature of gas processing, storage, and transportation activities. Overall, the residual impacts associated with the project are anticipated to be low to moderate in magnitude, localized in extent, and manageable with continuous monitoring and effective operational controls.

Air Quality and Emissions

During the operational phase of the LPG facility, the possibility of minor fugitive gas emissions cannot be completely eliminated, even with the use of leak detection systems, enclosed transfer mechanisms, and routine equipment maintenance. Such residual emissions may cause localized air quality deterioration and pose limited safety risks. However, with strict adherence to operational procedures and functional emergency response systems, residual impacts on ambient air quality are expected to remain minimal.

Soil and Groundwater Quality

Despite the installation of impermeable surfaces, spill containment systems, and strict handling procedures for hydrocarbons, a residual risk of soil or groundwater contamination may persist over the long term. Minor leakages or accidental spills during equipment servicing or gas handling could lead to localized soil degradation, particularly during heavy rainfall events if containment structures fail. These impacts are expected to be limited in scale and can be effectively managed through routine inspections and prompt remediation.

Noise Pollution

Residual noise impacts may continue during the operational phase, especially from vehicular movements, gas compression activities, and occasional pressure release operations. Although noise attenuation measures and controlled operational schedules will be implemented, some level of disturbance may still be experienced by nearby settlements around Birnin Kebbi Road, particularly during nighttime or peak operational periods.

Traffic and Road Safety

Increased movement of LPG transport trucks along access roads serving the project site may result in residual traffic-related impacts. Even with traffic management plans in place, risks associated with road congestion, vehicular accidents, and wear on local roads may persist, particularly at community junctions and pedestrian crossings frequently used by residents.

Occupational Health and Safety

Working within a high-pressure gas environment inherently carries residual occupational risks, including accidental gas release, fire hazards, and exposure to compressed gases. Although these risks are expected to be low with adequate training, use of personal protective equipment (PPE), and regular safety audits, they will require continuous enforcement of safety protocols throughout the project lifecycle.

Social and Community Relations

Residual social impacts may arise if community engagement initiatives and corporate social responsibility (CSR) programs are not sustained beyond the construction phase. Unrealized expectations regarding long-term employment or community development benefits could result in dissatisfaction among host communities in Birnin Kebbi Road. Continuous stakeholder engagement, transparent communication, and functional grievance redress mechanisms will be essential in minimizing such impacts.

Land Use and Visual Aesthetics

The establishment of a LPG facility within a predominantly rural and semi-agricultural landscape will result in a permanent alteration of land use and visual character. Even with landscaping and buffer zones, some community members may perceive the facility as visually intrusive. This impact is largely subjective but may influence community perceptions over time.

Biodiversity and Vegetation

Although the project area does not fall within a protected or ecologically sensitive zone, initial site preparation activities will lead to the permanent loss of some vegetation and minor displacement of fauna. While post-construction rehabilitation and greening efforts may reduce these effects, some level of ecological alteration will remain as a residual impact.

5.6.4 Cumulative Impacts of the Proposed LPG Project

Cumulative impacts refer to the combined effects of the proposed project when considered alongside past, existing, and reasonably foreseeable future developments within the project area (IFC, 2013). For the proposed LPG facility in Birnin Kebbi Road, cumulative impacts arise from interactions with ongoing and planned activities along the surrounding transport corridors and expanding settlements, including increased traffic, energy infrastructure development, agricultural activities, and peri-urban growth.

Cumulative Air Quality Effects

The Birnin Kebbi Road area already experiences emissions from vehicular traffic, small-scale industries, and domestic fuel use. Additional emissions from LPG transport vehicles and facility operations may cumulatively contribute to increased concentrations of particulate matter and gaseous pollutants. Over time, this could affect ambient air quality and increase respiratory health risks for vulnerable populations.

Cumulative Traffic and Road Infrastructure Pressure

The introduction of regular LPG haulage traffic will add to existing vehicular flows on access roads serving Birnin Kebbi Road and neighboring communities. When combined with agricultural transport and commuter traffic, this may accelerate road deterioration, increase travel delays, and elevate accident risks, particularly near markets and schools.

Cumulative Surface and Groundwater Pollution Risk

Although the LPG facility will employ containment and drainage controls, cumulative risks may arise from incremental contributions of runoff, minor spills, and existing pollution sources such as fuel stations, workshops, and agricultural inputs. Over time, this could increase the vulnerability of shallow aquifers and surface water resources relied upon by local communities.

Cumulative Noise and Vibration

Background noise levels from traffic and local economic activities may be amplified by project-related machinery and truck movements. The combined effect may lead to elevated ambient noise levels, potentially resulting in sleep disturbance, stress-related effects, and reduced quality of life for residents close to the facility.

Cumulative Ecological Stress

Although the direct footprint of the project is relatively limited, its contribution to broader land conversion and vegetation loss associated with settlement expansion may exacerbate habitat

fragmentation in the Birnin Kebbi Road area. This could reduce ecosystem services such as flood control, microclimate regulation, and soil stability.

Cumulative Social and Economic Impacts

While the project is expected to stimulate local employment and improve access to cleaner energy, cumulative development pressures may also result in social disparities if benefits are unevenly distributed. Rising land values, competition for resources, and unmet community expectations could generate social tension if not adequately managed.

Cumulative Greenhouse Gas Emissions

Although LPG is considered a cleaner alternative to conventional fossil fuels, the project will still contribute incrementally to regional greenhouse gas emissions when combined with other energy and transport infrastructure developments. Over the long term, this may contribute to climate change impacts at the regional scale.

Overall, the cumulative impacts associated with the proposed LPG project in Birnin Kebbi Road range from moderate to potentially significant if unmanaged. These impacts cut across environmental, social, health, and infrastructural sectors and highlight the need for coordinated planning, continuous monitoring, and collaboration with relevant authorities and stakeholders to minimize adverse effects while maximizing shared development benefits.

CHAPTER SIX

MITIGATION MEASURES

6.1 INTRODUCTION

This chapter outlines the mitigation measures proposed to address the potential adverse environmental and social impacts associated with the proposed LPG facility in Birnin Kebbi Road. The measures are intended to ensure that impacts identified across the pre-construction, construction, operation, and decommissioning phases of the project are effectively prevented, minimized, or managed within acceptable regulatory and environmental limits.

In developing the mitigation measures, due consideration was given to applicable national environmental regulations, international best practices, and the prevailing environmental and socio-economic conditions of the project area. The mitigation framework has been structured to ensure that project activities are carried out in an environmentally responsible and socially acceptable manner throughout the project lifecycle.

The general principles guiding the design of the mitigation measures include:

- avoidance of significant impacts, particularly where predicted effects may exceed established legal or regulatory standards or affect sensitive environmental or social receptors;
- reduction of moderate impacts to levels that remain within acceptable limits and standards, recognizing that such impacts may vary in magnitude but do not breach statutory thresholds; and
- management of minor impacts, where effects are expected to be low in intensity, remain well within permissible limits, and affect receptors of relatively low sensitivity or value.

The successful implementation of these mitigation measures will be supported through effective environmental management practices, continuous monitoring, clear institutional responsibilities, and ongoing stakeholder engagement to promote environmental protection, community safety, and sustainable development in Birnin Kebbi Road and surrounding communities.

6.2 YPES OF MITIGATION MEASURES

The mitigation measures proposed for the LPG project in Birnin Kebbi Road are grouped into three broad categories based on the timing and nature of their application. These include preventive measures, control measures, and compensatory measures. Together, these measures are designed to ensure that identified environmental and social impacts are either avoided or reduced to acceptable levels throughout the project lifecycle.

6.2.1 Preventive Measures

Preventive measures are incorporated primarily at the project design and pre-construction stages. Their primary objective is to eliminate or substantially reduce potential significant impacts at their source before project activities commence. For the proposed LPG facility in Birnin Kebbi Road, this approach emphasizes proactive planning and design optimization, such as appropriate site selection to avoid environmentally sensitive or densely populated areas, incorporation of safety buffers, and adoption of layouts that minimize land disturbance.

Preventive measures also include the modification or avoidance of activities that could generate adverse impacts, such as scheduling specific operations to reduce disturbance to nearby communities and implementing early stakeholder engagement and community sensitization programmes to prevent conflicts, manage expectations, and enhance local acceptance of the project.

6.2.2 Control Measures

Control measures are applied during the construction, commissioning, operation, and maintenance phases of the project. These measures are intended to manage, reduce, or contain impacts that cannot be completely avoided through design. For the Birnin Kebbi Road LPG project, control measures include on-site practices and engineering controls aimed at limiting emissions, noise, waste generation, traffic risks, and occupational health and safety hazards.

Where project activities result in unavoidable disturbance—such as vegetation clearance during site preparation—control measures also encompass remedial actions. These may include site restoration, re-vegetation of disturbed areas, proper waste handling, and continuous monitoring to

ensure that impacts remain within regulatory limits and do not adversely affect surrounding communities or ecosystems.

6.2.3 Compensatory Measures

Compensatory measures are considered where residual impacts remain after the application of preventive and control measures, or where impacts cannot be fully mitigated through technical or operational means. In such cases, appropriate compensation will be provided in line with applicable national regulations and guidelines issued by relevant authorities.

For the proposed LPG project in Birnin Kebbi Road, compensatory measures may include livelihood restoration support, community development initiatives, or other agreed forms of assistance aimed at offsetting losses or inconveniences experienced by affected individuals or communities.

6.3 MITIGATION MEASURES FOR SIGNIFICANT POTENTIAL ADVERSE IMPACTS

Based on the findings of the environmental and social impact assessment, a range of mitigation and enhancement measures have been identified to address the significant actual and potential adverse impacts associated with the proposed LPG project in Birnin Kebbi Road. These measures are designed to minimize negative impacts while enhancing positive outcomes, ensuring that the project is implemented in an environmentally sustainable and socially responsible manner in accordance with national standards and international best practice.

Table 6.1a: Mitigation Measures for the Proposed Project (Preconstruction stage)

S/N	Activity	Associated Impact	Mitigation Measure	Responsible Party	Monitoring Indicator	Frequency
1	Land Acquisition	Loss of land, displacement	ZAGR shall provide fair compensation and resettlement assistance based on national laws and IFC standards	ZAGR, FMEnv, SASEPA	Compensation records, grievance log	One-off
2	Land Acquisition	Loss of livelihood for farmers and informal users	ZAGR shall implement a Livelihood Restoration Plan (LRP)	ZAGR, Independent Monitor	LRP implementation report	Quarterly
3	Land Acquisition	Third-party agitation	ZAGR shall engage traditional leaders and affected stakeholders before and after compensation	ZAGR, Community Liaison Officer	Community meeting records, conflict reports	Monthly
4	Community Sensitization	Raised expectations, exclusion of vulnerable groups	ZAGR shall conduct inclusive stakeholder engagement targeting women, youth, and vulnerable populations	ZAGR, NGO Partner	Attendance lists, communication log	Bi-monthly
5	Site Survey & Soil Testing	Soil compaction, minor vegetation loss	ZAGR shall use low-impact techniques and avoid sensitive areas	Contractor, HSE Supervisor	Site disturbance map, field reports	Per
6	Equipment Mobilization	Traffic congestion, road safety hazards	ZAGR shall develop a Traffic Management Plan and notify communities in advance	ZAGR, Transport Contractor		Traffic incident reports, logbooks
7	Equipment Mobilization	Noise and short-term emissions	ZAGR shall operate during daylight only and use mufflers for trucks	ZAGR, Contractor		Noise logs,
8	Influx of Job Seekers	Pressure on services, housing, tensions	ZAGR shall recruit from host community and collaborate with local councils	ZAGR HR Unit, CLO		time logs of
9	Influx of Job Seekers	Cultural and recruitment conflicts	ZAGR shall publish transparent recruitment criteria and grievance redress process	ZAGR, Community Liaison		delivery Local hire

S/N	Activity	Associated Impact	Mitigation Measure	Responsible Party	Monitoring Indicator	Frequency
10	Site Clearing	Loss of biodiversity and habitats	ZAGR shall demarcate no-go zones and minimize clearance to approved limits	HSE Officer, Contractor	Clearing limits map, flora/fauna observation logs	Weekly
11	Site Clearing	Soil erosion	ZAGR shall install temporary erosion control structures (silt fences, mulching)	HSE Unit, Field Engineer	Soil exposure logs, erosion risk assessments	Weekly
12	Initial Waste Generation	Littering, improper waste disposal	ZAGR shall provide bins and contract waste handlers	Waste Manager, HSE Unit	Waste manifests, site inspection reports	Weekly
13	Initial Waste Generation	Visual nuisance	ZAGR shall implement daily cleanup and screen waste storage areas	Contractor, Site Supervisor	Daily site inspection checklist	Daily

Table 6.1b: Mitigation Measures for the Proposed Project (construction stage)

S/N	Activity	Associated Impact	Mitigation Measure (ZAGR shall...)	Responsible Party	Monitoring Indicator	Frequency
1	Civil works (earthworks, foundations)	Soil disturbance and erosion	Implement erosion control (silt fences, berms); schedule works during dry season	Contractor, HSE Officer	Sediment load checks, soil stabilization maps	Weekly
2	Civil works (roads, drainage)	Construction waste (blocks, metal, cement bags)	Segregate waste and contract licensed disposal vendors	ZAGR Waste Coordinator	Waste logs, vendor records	Weekly
3	Installation of LPG tanks	Occupational risk from heavy lifting	Use cranes with certified riggers; enforce lifting SOPs and PPE use	ZAGR Mechanical Unit	Lifting permits, toolbox talk records	Daily
4	Installation of pumps and compressors	Noise exposure	Install noise dampeners; restrict operations to daylight hours	Contractor, HSE Unit	Noise readings (dB), complaint records	Weekly
5	Piping and valve welding	Fire hazard, fumes, exposure risks	Enforce hot work permit process, deploy fire watchers, and provide PPE	ZAGR Safety Supervisor	Work permits, fire extinguisher logs	Daily

S/N	Activity	Associated Impact	Mitigation Measure (ZAGR shall...)	Responsible Party	Monitoring Indicator	Frequency
6	Fire hydrant & safety system works	Minor emissions, spark risk	Assign trained technicians, implement spark containment plan	Fire Safety Officer	Incident log, observation checklist	Weekly
7	Electrical installation	Electrocution and fire hazard	Install GFCI breakers, verify all testing phases under supervision	Electrical Engineer, QA/QC	Electrical test reports, EHS inspection checklist	Per activity
8	Hydro testing of pipelines and tanks	Hydro test water contamination	Use biodegradable chemicals; treat water prior to discharge	Contractor, Environmental Lead	Hydrotest logs, effluent test results	Per hydrotest
9	Generator and equipment operation	Noise, vibration, air pollution	Service generators monthly; install silencers and bunded fuel storage	ZAGR Engineering/HSE Unit	Emissions reports, vibration log	Monthly
10	General construction	Injuries to workers or public	Conduct daily safety briefings, ensure availability of first aid and rescue tools	HSE Supervisor, Contractor	Incident register, PPE compliance check	Daily

Table 6.1c: Mitigation Measures for the Proposed Project (Operation stage)

S/N	Activity	Associated Impact	Mitigation Measure (ZAGR shall...)	Responsible Party	Monitoring Indicator	Frequency
1	LPG tanker delivery	Traffic congestion, vehicular emissions, road accidents	Enforce delivery scheduling, vehicle checks, trained drivers, and install traffic signage	Logistics Officer, HSE Unit	Vehicle inspection log, incident reports	Weekly
2	LPG unloading into tanks	Risk of gas leaks, explosion, pressure build-up	Install ESD valves, gas detectors, overfill alarms, and operator training	Engineering Supervisor	LEL sensor readings, maintenance reports	Monthly
3	Compressor and pump operations	Mechanical noise, overheating, equipment failure	Enclose equipment in noise-proof housing, maintain on schedule	Maintenance Team	Decibel meter readings, downtime reports	Monthly

S/N	Activity	Associated Impact	Mitigation Measure (ZAGR shall...)	Responsible Party	Monitoring Indicator	Frequency
4	Generator operation	GHG emissions, vibration, noise	Use low-emission generators, routine servicing, install dampeners	Engineering/HSE Unit	Emission logs, vibration measurement	Quarterly
5	Gas metering and control	Calibration errors, supply inconsistency	Calibrate meters periodically, install pressure regulators and safety shutoffs	Process Control Engineer	Calibration certificate, inspection log	Monthly
6	Filling of LPG cylinders and skids	Fire/explosion from overpressure	Use auto-stop filling nozzles, monitor tank pressure, enforce PPE	Filling Supervisor	Pressure gauge log, PPE audit	Daily
7	Routine maintenance	Occupational injuries from tools and equipment	Train staff, supervise all work-at-height and confined space jobs, use certified tools	HSE/Operations Team	Incident reports, job hazard analysis (JHA) records	Daily
8	Waste handling and condensate removal	Spill or leakage from storage tanks	Segregate waste, provide sealed drums, and use NMDPRA-accredited waste vendors	Waste Manager	Waste tracking log, spill response drills	Monthly
9	Community engagement & CSR	Rising expectations, perception of neglect	Maintain an active grievance redress mechanism, hold quarterly forums	Community Liaison Officer	Stakeholder meeting records, grievance log	Quarterly
10	Gas distribution & sales	Long-term increase in public reliance and safety risks	Conduct public safety education and enforce strict distribution SOPs	Business Operations Lead	Safety training attendance, incident reports	Quarterly

Table 6.1d: Mitigation Measures for the Proposed Project (Decomissioning stage)

S/N	Activity	Associated Impact	Mitigation Measure (ZAGR shall...)	Responsible Party	Monitoring Indicator	Frequency
1	Decommissioning planning	Community unrest, uncertainty	Develop and communicate a Decommissioning Plan; consult stakeholders early	Project Lead, Community Liaison	Number of meetings held, community response logs	Monthly
2	Equipment dismantling	Injuries, falling objects, burns	Provide PPE, trained dismantling crew, and enforce permit-to-work system	Decommissioning Contractor, HSE	Incident records, PPE compliance checklist	Daily
3	Hazardous waste removal	Contamination from residuals, improper disposal	Conduct environmental audit, segregate hazardous waste, and contract NMDPRA-approved vendor	Waste Manager, Environmental Lead	Waste manifests, disposal receipts	Per activity
4	Soil/site restoration	Soil compaction, altered drainage	Regrade, loosen compacted soil, ZAGRant with native species	Civil Supervisor, HSE Team	Site photos, topsoil condition log	Weekly
5	Disengagement of staff	Loss of income, dissatisfaction	Provide severance packages, notice letters, and facilitate re-employment support	HR Department, CLO	Exit interviews, complaint/grievance reports	One-off
6	Infrastructure removal	Damage to nearby utilities	Conduct pre-removal site inspection and coordinate with utility companies	Site Engineer, Utility Supervisor	Inspection reports, utility protection measures log	Before & after dismantling
7	Final site audit and documentation	Non-compliance with closure obligations	Conduct final audit, prepare decommissioning report and submit to FMEnv	Compliance Unit, External Auditor	Final audit report, FMEnv acknowledgment	Once-off (project close)

Discussion of Mitigation measures

Mitigation Measures for Environmental and Social Impacts during the Preconstruction Phase

The preconstruction phase of the proposed Liquefied Petroleum Gas (LPG) Project in Birnin Kebbi Road, Bodinga Local Government Area of Sokoto State presents a range of environmental and social risks which, if not adequately managed, could negatively affect the project environment and surrounding host communities. This phase comprises preparatory activities such as site reconnaissance and layout planning, land acquisition, vegetation and bush clearing, geotechnical investigations, and the mobilization of personnel and equipment. Although these activities precede full-scale construction, they have the potential to generate notable environmental and social impacts that necessitate well-defined mitigation measures.

One of the key environmental concerns during this phase is the loss of vegetation and disturbance of local habitats resulting from land clearing and site preparation. To minimize this impact, vegetation removal will be strictly limited to areas required for the immediate development of the LPG facility. Buffer zones around the site will be preserved to maintain ecological stability, while selective clearing will be applied to retain mature and economically or ecologically important tree species where feasible. In addition, topsoil will be carefully removed, stored separately, and reused during site reinstatement and landscaping activities to preserve soil fertility.

Soil erosion and dust generation may also occur as a result of ground disturbance and earthworks. To mitigate these impacts, land clearing activities will be properly phased and undertaken under controlled conditions to reduce exposure of bare soil surfaces. Water sprinkling will be carried out regularly on exposed areas and access roads to suppress dust, particularly in sections close to residential areas within Birnin Kebbi Road and adjoining settlements. Where necessary, temporary drainage channels, silt fences, and sediment traps will be installed to prevent soil wash-off and sedimentation of nearby drainage paths during rainfall events.

Noise and air emissions associated with the mobilization of equipment, vehicles, and geotechnical testing activities are expected to be short-term but potentially disruptive. Mitigation measures will include the use of well-maintained, low-emission machinery and generators, as well as strict

adherence to approved working hours to limit disturbance to nearby households. Equipment with excessive noise levels, faulty exhaust systems, or oil leaks will not be permitted on site. Workers will be provided with appropriate personal protective equipment, including ear protection and dust masks, to minimize occupational exposure.

Social risks related to land acquisition, access restriction, and compensation may arise if affected persons perceive the process as unfair or inadequately communicated. To address this, the project proponent will implement a structured stakeholder engagement process, ensuring early consultation with community leaders, landowners, and other affected stakeholders in Birnin Kebbi Road. Where land acquisition or livelihood disruption is unavoidable, compensation will be carried out in line with applicable Nigerian regulations and best practice standards, based on full value for affected assets, crops, and economic trees.

There is also the possibility of encountering cultural or religious assets during site preparation. To manage this risk, a chance-find procedure will be incorporated into site operations. Any discovery of cultural materials, shrines, or heritage features will trigger an immediate suspension of work in the affected area, followed by notification of relevant traditional authorities and government agencies for guidance on appropriate actions.

Community health and safety risks may arise from increased vehicular movement, the presence of unfamiliar workers, and temporary changes in land use. To mitigate these risks, the project will carry out community sensitization programmes to inform residents about planned activities, timelines, and safety precautions. Traffic control measures, including warning signs and speed limits, will be enforced on access roads, while temporary fencing will be installed to restrict unauthorized access to work areas, particularly by children.

Worker welfare will be prioritized through pre-employment medical screening, site induction training, and enforcement of occupational health and safety standards. Adequate welfare facilities, including potable water, sanitation, and rest areas, will be provided on site. The use of child labour or informal labour will be strictly prohibited.

To ensure effective implementation of all mitigation measures during the preconstruction phase, an Environmental and Social Management Plan (ESMP) will be operationalized prior to

commencement of site activities. A designated Environmental and Social Officer (ESO) will be responsible for monitoring compliance, liaising with host communities, managing grievances, and ensuring that all mitigation commitments are effectively implemented and documented.

Mitigation Measures for Environmental and Social Impacts during the Construction Phase

The construction phase of the proposed LPG facility in Birnin Kebbi Road**,** involves intensive civil, mechanical, and infrastructural activities. These include site levelling and grading, excavation and earthworks, foundation construction, installation of LPG storage and compression units, laying of pipelines, provision of utilities, as well as construction of internal access roads and drainage systems. While these activities are essential for project development, they present a number of environmental and social risks that require effective mitigation to safeguard environmental quality and community wellbeing.

A major environmental concern during construction is the deterioration of air quality, mainly arising from dust generated during excavation, material handling, and vehicular movement, as well as emissions from diesel-powered equipment. To reduce these impacts, exposed soil surfaces and haul routes will be regularly watered, trucks conveying loose materials will be adequately covered, and modern, low-emission machinery will be used. Routine maintenance of construction equipment will be enforced, and unnecessary engine idling will be discouraged to limit exhaust emissions.

Noise and vibration from construction machinery, generators, and related activities may affect nearby settlements within and around Birnin Kebbi Road. To mitigate this, high-noise activities will be restricted to daytime hours, generally between 8:00 a.m. and 6:00 p.m. Noise-reducing devices such as silencers and acoustic enclosures will be installed on equipment where required, and all machinery will be maintained according to manufacturer specifications. Construction workers exposed to elevated noise levels will be provided with appropriate personal protective equipment (PPE), while periodic noise monitoring will be conducted to ensure compliance with national and international standards.

The risk of soil and water contamination during construction may arise from accidental spills of fuel, lubricants, cement slurry, or other construction-related chemicals. To manage this risk,

designated refuelling and equipment maintenance areas will be established on impermeable surfaces fitted with secondary containment systems. Construction personnel will be trained in the safe handling and storage of hazardous materials, and spill response kits will be readily available on site. Wastewater from construction activities will be properly contained and treated before discharge or disposal.

Effective management of construction and solid waste will be prioritized throughout this phase. A site-specific waste management plan will be implemented to promote waste minimization, segregation, reuse, and recycling. Separate receptacles will be provided for different waste streams, including metals, plastics, and hazardous wastes, while disposal will be handled by licensed waste contractors in accordance with regulatory requirements. Open burning of waste materials will be strictly prohibited.

With respect to biodiversity and land disturbance, construction activities will be confined strictly to the approved project footprint to minimize unnecessary vegetation removal. Natural drainage patterns will be preserved as much as possible, and stockpiled topsoil will be reused during post-construction site reinstatement and landscaping to promote vegetation recovery and soil stability.

From a social standpoint, increased movement of construction vehicles and personnel may elevate the risk of traffic congestion and road accidents along local access roads serving Birnin Kebbi Road. To mitigate this, a traffic management plan will be implemented, including the use of warning signs, speed limits, designated access routes, and trained traffic marshals where necessary. Delivery of construction materials will be scheduled, as far as practicable, during off-peak hours to reduce interference with local traffic and community activities.

Occupational and public health and safety will be addressed through the implementation of a comprehensive Health, Safety, and Environment (HSE) management system. All workers will undergo site induction and safety training, make use of appropriate PPE, and have access to potable water, sanitation, and welfare facilities. First-aid equipment and trained personnel will be available on site, and emergency response procedures will be established to manage incidents such as accidents, fires, or spills.

Potential social risks, including community tension or inappropriate interactions between workers and residents, will be managed through enforcement of a workers' code of conduct. The employment of underage or unregistered workers will be prohibited, and a functional grievance redress mechanism (GRM) will be established to allow community members to report concerns. Sensitization programmes focusing on cultural respect, gender protection, and acceptable workplace behaviour will be conducted periodically.

Public health risks, including the spread of communicable diseases, will be mitigated through strict hygiene practices, provision of sanitation facilities, and collaboration with local health authorities. Where temporary worker accommodation is required, such facilities will be sited away from residential areas and designed to meet acceptable standards for water supply, waste disposal, ventilation, and space.

Continuous community engagement will be maintained throughout the construction phase. A designated Community Liaison Officer (CLO) will facilitate communication between the project team and host communities, manage expectations, and ensure timely resolution of complaints. Environmental and social monitoring will be conducted regularly, and mitigation measures will be reviewed and adjusted where necessary to ensure effectiveness.

Mitigation Measures for Environmental and Social Impacts During the Operation Phase

The operation phase of the proposed LPG facility in Birnin Kebbi Road represents the period of active gas compression, storage, and distribution. This phase introduces specific environmental, health, and social risks associated with the handling of pressurized natural gas, vehicular movement, waste generation, and long-term interaction with surrounding communities. Appropriate mitigation measures are therefore essential to ensure safe operations, environmental protection, and regulatory compliance.

A critical risk during operation is the potential for fire or explosion due to the flammable nature of Liquefied Petroleum Gas. To mitigate this risk, the facility will be designed, constructed, and operated in accordance with applicable Nigerian regulatory requirements and internationally recognized safety standards. The facility will be equipped with gas leak detection systems, fire suppression equipment, emergency shutdown mechanisms, and flame control devices installed at

critical points. Regular inspection and maintenance of compressors, pipelines, valves, and storage systems will be mandatory. Emergency preparedness measures, including fire drills and staff training, will be conducted routinely in collaboration with relevant emergency services.

Operational air emissions may result from venting activities, equipment operation, and backup power generation. These impacts will be minimized through the use of closed or controlled venting systems, energy-efficient equipment, and strict maintenance schedules. Air quality monitoring will be conducted periodically within and around the facility to ensure that emission levels remain within permissible limits.

Noise generated from compressors, pumps, and vehicle movement within the facility may affect both workers and nearby residents. Noise mitigation will include installation of silencers, acoustic insulation around noisy equipment, and the construction of noise barriers where required. Operational activities will be managed to minimize nighttime disturbances, and routine noise monitoring will be carried out in line with regulatory guidelines.

Operational waste streams, including used oils, lubricants, packaging materials, and minor process wastes, will be managed under a dedicated Waste Management Plan. Waste will be segregated, safely stored, and disposed of through licensed waste handlers in accordance with Sokoto State and national environmental regulations. Hazardous wastes will be stored in labeled, sealed containers on impermeable surfaces prior to disposal at approved facilities.

To prevent soil and groundwater contamination, the facility will incorporate containment structures such as bunds, impervious flooring, and oil–water separators within the drainage system. Storage tanks and pipelines will be fitted with leak detection systems, and any identified leaks will be addressed immediately through corrective and remediation measures.

From a social perspective, the operational phase may lead to increased traffic associated with gas transport vehicles. A traffic management strategy will be implemented to regulate truck movement, optimize delivery routes, provide adequate parking or holding areas, and coordinate with traffic authorities. Warning signage and safety information will be provided along access roads to protect other road users.

Occupational health and safety will remain a priority throughout the operational life of the project. Workers will receive continuous training on emergency response, hazardous materials handling, and use of PPE. Health surveillance, incident reporting, and on-site medical support will be maintained under the supervision of a dedicated Health, Safety, and Environment Officer.

Community concerns regarding safety, environmental performance, and long-term impacts will be addressed through ongoing stakeholder engagement and a functional grievance redress mechanism. Regular meetings will be held with community representatives to provide information on operations and receive feedback. Where feasible, corporate social responsibility initiatives such as skills development, minor infrastructure support, or community services may be implemented to strengthen community–project relations.

Visual and landscape impacts associated with the facility will be mitigated through perimeter fencing, landscaping, and planting of vegetation buffers. These measures will enhance aesthetics, reduce dust dispersion, and contribute to noise attenuation.

Mitigation Measures for Environmental and Social Impacts During the Decommissioning Phase

The decommissioning phase of the proposed project represents the final stage of the project lifecycle. This phase involves the systematic shutdown of operations, dismantling of LPG equipment and infrastructure, removal of installations, and safe disposal or recycling of materials once the facility has reached the end of its useful life. Although decommissioning activities are typically short-term, they may give rise to notable environmental and social impacts if not properly planned and managed. Consequently, appropriate mitigation measures will be implemented to minimize risks and ensure environmental protection and community safety.

Key environmental and social risks associated with decommissioning include the generation of hazardous and non-hazardous waste, potential air and noise pollution, soil and groundwater contamination, occupational health and safety hazards, disruption to nearby communities, and loss of employment and local economic activities. To effectively manage these risks, the project proponent will develop and implement a Decommissioning and Site Restoration Plan in line with Federal Ministry of Environment (FMEnv) requirements and relevant international best practices.

One of the major environmental concerns during decommissioning is the potential release of residual hazardous substances, including compressed gas residues, lubricants, and industrial chemicals. Prior to dismantling activities, the facility will be thoroughly decommissioned through controlled depressurization and decontamination procedures. All LPG storage vessels, compressors, and pipelines will be safely emptied, purged, and cleaned. Wastewater generated from cleaning operations will be collected, treated, and disposed of in accordance with applicable environmental regulations. Any residual LPG will be safely transferred to approved facilities to eliminate risks of accidental release or explosion.

Measures will be taken to prevent soil and groundwater contamination during dismantling activities. Surface and subsurface structures will be removed carefully, and excavated areas will be inspected and sampled to detect possible contamination. Where contamination is identified, appropriate remediation measures—such as soil excavation, treatment, or containment—will be undertaken. Secondary containment systems, including impermeable liners and bunds, will be used during equipment removal to prevent accidental spills.

Air quality and noise impacts associated with demolition equipment and vehicle movement will be minimized through the use of modern, low-emission machinery and proper maintenance of all equipment. High-noise activities will be limited to daytime hours to reduce disturbance to residents of Birnin Kebbi Road and surrounding settlements. Dust emissions will be controlled through regular water spraying of work areas and access routes, while temporary noise barriers may be installed where required.

The decommissioning phase is expected to generate various waste streams, including scrap metal, concrete debris, cables, packaging materials, and other demolition wastes. A dedicated Waste Management Plan will guide the segregation, recycling, and disposal of all wastes through licensed waste management contractors. Hazardous materials, such as oil-contaminated components or pressurized equipment, will be handled using strict safety procedures and disposed of at approved hazardous waste facilities.

From a social perspective, the cessation of operations may result in job losses for facility workers and reduced income for local service providers. To mitigate these impacts, the project proponent

will implement a workforce transition strategy that includes advance notice of closure, payment of statutory severance benefits, and, where feasible, retraining or redeployment opportunities within other company operations. This approach will help ease the socioeconomic adjustment of affected workers.

Ensuring the safety of workers and nearby communities during dismantling activities is a critical priority. All decommissioning works will comply with established Occupational Health and Safety (OHS) standards. Workers will receive specialized training on decommissioning procedures, hazardous material handling, and emergency response. The use of appropriate personal protective equipment (PPE) will be mandatory, and work areas will be clearly demarcated and secured to prevent unauthorized access by community members.

To reduce potential community disturbance arising from increased truck movements and demolition activities, the project will engage local leaders and residents ahead of time to communicate schedules and safety measures. Traffic management measures, including speed limits, signage, and temporary diversions, will be implemented on local access roads serving Birnin Kebbi Road to ensure public safety. A grievance redress mechanism will remain active throughout the decommissioning period to address any concerns raised by the community.

Following completion of dismantling activities, the project site will be rehabilitated to a stable and safe condition. Site restoration measures may include land grading, soil reconditioning, and revegetation to prevent erosion and restore the landscape. In consultation with relevant authorities and community stakeholders, the rehabilitated land may be repurposed for agriculture or other community-beneficial uses consistent with local development plans.

Where Corporate Social Responsibility (CSR) initiatives were implemented during the operational phase, appropriate transition arrangements will be made to gradually hand over such support to community institutions or government agencies, thereby avoiding abrupt withdrawal and minimizing adverse social effects.

Mitigation Measures for Cumulative Impacts

Cumulative impacts result from the combined and incremental effects of multiple activities and developments occurring within the same geographic area over time. For the proposed LPG facility, such impacts may arise from interaction with existing and planned developments, increased traffic along the Sokoto–Zaria Road, agricultural land use, and gradual population growth in Birnin Kebbi Road and neighbouring settlements. If not properly managed, cumulative impacts may lead to deterioration of environmental quality and increased social pressure on host communities.

To address these potential effects, an integrated and proactive mitigation approach will be implemented, covering air quality, water resources, noise, biodiversity, land use, traffic, and socioeconomic conditions.

Strategic Environmental Management and Coordination

The project proponent will collaborate with relevant government agencies, local authorities, and nearby operators to ensure coordinated planning and implementation of activities. This includes harmonising construction and operational schedules, shared use of infrastructure such as access roads and waste disposal facilities, and avoidance of resource conflicts.

A Cumulative Impact Management Plan (CIMP) will be developed, incorporating shared baseline data, coordinated monitoring programmes, and periodic cumulative impact assessments to guide adaptive management.

Air Quality and Emissions Control

To minimise cumulative air quality impacts, the facility will deploy low-emission equipment, leak detection and repair systems, and efficient gas handling technology. Green buffer zones comprising trees and shrubs will be established around the site to reduce dust dispersion and absorb gaseous pollutants. In addition, strict vehicle emission standards will be enforced for haulage trucks and staff vehicles to prevent regional air quality degradation.

Water Resource Protection

The project will adopt coordinated water abstraction practices to avoid excessive pressure on shared groundwater resources. Wastewater generated will meet FMEnv discharge limits, especially where multiple users rely on common drainage channels or irrigation systems. Rainwater harvesting systems will be incorporated to reduce reliance on public water sources and limit cumulative surface runoff and flooding risks.

Noise and Vibration Management

High-noise activities will be scheduled to avoid overlap with similar activities from nearby developments, thereby preventing excessive cumulative noise exposure to surrounding communities. The use of low-noise machinery and routine equipment maintenance will further reduce background noise levels.

Land Use and Biodiversity Protection

Existing agricultural land and green spaces between the project site and neighbouring developments will be preserved to minimise habitat fragmentation. Ecologically sensitive areas such as drainage channels and remnant vegetation will be designated as no-go zones to prevent encroachment by current or future activities.

Traffic and Infrastructure Management

Traffic movements associated with the LPG facility will be coordinated with relevant authorities and other road users along the eastern bye-pass Zaria Road to reduce congestion and infrastructure stress. Fuel deliveries and service trips will be staggered and scheduled during off-peak hours. Where necessary, the project will contribute to the maintenance of roads affected by cumulative truck movements in partnership with local authorities and other operators.

Social and Community Wellbeing

The project will collaborate with neighbouring facilities to implement shared Corporate Social Responsibility (CSR) initiatives such as water supply projects, educational support, and skills development programmes, ensuring efficient use of resources and broader community benefits.

Employment practices will be coordinated to avoid labour competition and social tension within host communities.

Institutional and Regulatory Engagement

Periodic cumulative impact reviews will be encouraged in collaboration with the Federal Ministry of Environment and Sokoto State Ministry of Environment. Findings from cumulative assessments will be documented in the project's Annual Environmental Compliance Reports, with specific actions identified to address emerging cumulative issues.

Mitigation Measures for Residual Impacts

Residual impacts are those environmental and social effects that remain after all practicable mitigation measures have been implemented. Although generally minor, these impacts may persist over the long term and therefore require continuous management to sustain environmental quality and community acceptance.

Residual Air Quality Impacts

Minor emissions from gas handling, vehicular movement, and maintenance activities may persist.

Mitigation Measures

- Continuous monitoring of $PM_{2.5}$, VOCs, and NO_x using fixed air quality sensors.
- Regular maintenance and upgrading of gas handling and leak-prevention systems.
- Enforcement of low vehicle speed limits within the facility to reduce dust.
- Periodic inspection and auditing of transfer hoses, valves, and fittings.

Residual Noise Impacts

Low-level noise from compressors, generators, and truck movements may continue, particularly during operational hours.

Mitigation Measures

- Installation of acoustic enclosures and perimeter noise barriers around key equipment.

- Restriction of noisy activities to daytime periods.
- Periodic noise monitoring in accordance with FMEnv and WHO standards.
- Provision of targeted mitigation (e.g., improved building insulation) for the most affected receptors where necessary.

Residual Water and Soil Impacts

Small-scale contamination from runoff or accidental leaks may occur over time.

Mitigation Measures

- Maintenance of impermeable surfaces and drainage interceptors in gas handling areas.
- Long-term groundwater monitoring within the project influence zone.
- Installation and maintenance of oil-water separators for stormwater systems.
- Annual emergency response training and spill control dZAGRls.

Residual Traffic and Road Safety Impacts

Low-level congestion and gradual road wear may persist on access routes.

Mitigation Measures

- Financial or logistical support for routine road maintenance.
- Use of delivery scheduling and tracking systems to avoid peak traffic periods.
- Implementation of community road safety measures, including signage and pedestrian awareness.

Residual Health and Safety Impacts

Minor risks related to emissions exposure, fire hazards, or long-term stress may remain.

Mitigation Measures

- Ongoing community health awareness programmes in collaboration with local health facilities.
- Establishment of a dedicated Health, Safety and Environment (HSE) grievance desk.

- Regular inspection and maintenance of fire-fighting and emergency alert systems.

Residual Socioeconomic Impacts

Unequal perception of project benefits may lead to latent dissatisfaction.

Mitigation Measures

- Operation of a Community Liaison Office with regular engagement meetings.
- Equitable distribution of CSR interventions across host and neighbouring communities.
- Support for vocational training, small business development, and women and youth empowerment.

Residual Visual and Aesthetic Impacts

Project infrastructure may alter the local landscape.

Mitigation Measures

- Landscaping with native trees and shrubs around the facility perimeter.
- Use of neutral, earth-tone colours for structures.
- Installation of anti-glare lighting and downward-directed fixtures.

Residual Climate Change Impacts

Residual greenhouse gas emissions may contribute to long-term climate effects.

Mitigation Measures

- Annual accounting and reporting of GHG emissions using recognised protocols.
- Tree-planting and carbon offset initiatives in collaboration with relevant state agencies.
- Integration of renewable energy sources, such as solar power, for auxiliary operations.

Residual impacts will be continuously monitored, reviewed, and managed through the project's Environmental and Social Management Plan (ESMP) to ensure adaptive management, regulatory compliance, and sustained community trust.

CHAPTER SEVEN

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

7.1 INTRODUCTION

Environmental management involves a structured and integrated approach designed to ensure that both identified and unforeseen impacts of a proposed project are effectively controlled and reduced to acceptable levels. It assures project proponents and planners that appropriate systems and procedures will be in place to address potential environmental, social, and health issues throughout all stages of the project, from initial planning and design through operation and eventual decommissioning.

The Environmental Management Plan (EMP) serves as the principal instrument for managing the anticipated impacts of the project. It provides a practical framework for implementing, monitoring, and reviewing mitigation measures aimed at reducing moderate and significant adverse impacts to levels that are as low as reasonably practicable (ALARP) over the entire project lifecycle. Through the EMP, identified environmental, social, and health risks are systematically managed, ensuring compliance with regulatory requirements and promoting sustainable project development.

7.2 OBJECTIVES OF THE ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) for the proposed LPG project in Birnin Kebbi Road is designed to provide a systematic framework for managing environmental, social, health, and safety issues throughout the project lifecycle. The specific objectives of the EMP are to:

- Ensure that all project activities, including pre-construction, construction, operation, and decommissioning, are carried out in full compliance with applicable national regulations, guidelines, and environmental and safety standards relevant to LPG facilities.
- Ensure that construction and operational procedures are planned and implemented in a manner that minimizes adverse impacts on the biophysical environment, public health, and

the socio-economic wellbeing of the host community, with the ultimate goal of preventing or eliminating such impacts where practicable.

- Promote, achieve, and demonstrate sound environmental performance for the project, guided by the principle of continuous improvement in environmental and social management.
- Ensure that all mitigation and enhancement measures identified in the Environmental Impact Assessment for the LPG project are effectively implemented, monitored, and maintained.
- Ensure that adequate emergency preparedness and response measures are in place to address accidental events, system failures, or loss of control during project implementation and operation.
- Provide a clear basis and performance standards for planning, environmental monitoring, auditing, reporting, and periodic review of environmental and social performance throughout the life of the LPG project.
- Facilitate early and continuous consultation with host communities, relevant regulatory agencies, and other stakeholders to promote smooth project implementation and address concerns proactively.
- Establish an institutional and management structure that ensures full compliance with the EMP by the project proponent and all contractors engaged in the execution of the LPG project.

7.3 SCOPE OF THE ENVIRONMENTAL MANAGEMENT PLAN

The scope of the Environmental Management Plan (EMP) for the proposed LPG project in Birnin Kebbi Road covers all critical activities and phases of the project, from pre-construction through operation and eventual decommissioning. The EMP is structured to achieve the following:

- Clearly define the institutional roles and responsibilities of the project proponent, contractors, and relevant regulatory agencies involved in the implementation of the LPG project.
- Establish clear, specific, and measurable environmental, social, health, and safety targets and performance standards that must be complied with throughout the project lifecycle.

- Put in place effective procedures for communication, environmental monitoring, documentation, reporting, and information disclosure to ensure transparency and regulatory compliance.
- Systematically identify potential environmental and social risks associated with the LPG project and prescribe appropriate mitigation, control, and corrective measures.
- Provide for capacity building through training and awareness programs aimed at strengthening the ability of project staff and contractors to implement the EMP effectively and sustainably.

7.2 ROLES AND RESPONSIBILITIES

Effective implementation of the Environmental Management Plan (EMP) for the proposed project requires the coordinated involvement of multiple stakeholders, each performing clearly defined roles across the pre-construction, construction, operation, and decommissioning phases of the project. This collaborative framework ensures that environmental, social, health, and safety risks associated with the LPG project are properly managed in line with regulatory requirements and best practices. Where project activities require modification at any stage, the project proponent shall be consulted and approvals obtained from relevant authorities.

Project Proponent (ZAGR)

ZAGR, as the developer and operator of the LPG facility in Birnin Kebbi Road, together with its employees and representatives, shall be responsible for the overall execution and enforcement of the EMP. Key responsibilities include the following:

- Ensuring that all personnel involved in the LPG project are fully familiar with the contents and requirements of the EMP.
- Providing regular progress updates to relevant stakeholders, including regulators and host communities, through written reports and verbal briefings.
- Requesting, reviewing, and approving method statements and work plans prepared by contractors, in consultation with the appropriate regulatory authorities.
- Reviewing and approving site layout designs, including access roads, haulage routes, equipment placement, and safety zones within the LPG facility.

- Advising on suitable materials and methods for demarcating work areas and carrying out construction and operational activities safely.
- Issuing site instructions to ensure compliance with regulatory conditions and environmental requirements.
- Notifying regulatory authorities in advance, both verbally and in writing, of any planned activities that may pose potential environmental or social risks.
- Conducting environmental damage assessments following incidents, accidents, or serious cases of non-compliance.
- Reviewing complaints received from workers or community members and issuing corrective instructions where necessary.
- Allocating and managing budgets for environmental control measures, personnel deployment, monitoring equipment, and capacity-building initiatives related to the LPG project.
- Accompanying regulators during site inspections and formally communicating any proposed amendments to the EMP.
- Enforcing temporary suspension of activities where serious environmental violations or safety risks are identified.
- Maintaining a complaints and grievance register and forwarding relevant information to appropriate authorities.
- Promoting proactive communication among contractors, regulators, community representatives, and other stakeholders to enhance environmental performance.
- Implementing, managing, and maintaining all EMP requirements applicable to construction and operational activities throughout the project duration.
- Appointing qualified personnel to oversee environmental, health, and safety management during LPG operations.
- Delegating responsibilities clearly to ensure accountability in EMP implementation.
- Ensuring that all contractors and subcontractors understand and comply with their environmental and social obligations under the EMP.

Regulatory Authorities

Oversight and monitoring of EMP implementation for the Birnin Kebbi Road LPG project shall be the responsibility of relevant regulatory bodies, including the Federal Ministry of Environment (FMEnv)**, the** Department of Petroleum Resources (DPR)/NUPRC**,** and other applicable agencies. Their responsibilities include, but are not limited to, the following:

- Enforcing national environmental laws, guidelines, standards, and sector-specific regulations applicable to LPG infrastructure and operations.
- Ensuring compliance with the conditions and commitments outlined in the EMP throughout the entire lifecycle of the project.
- Taking necessary enforcement actions to address non-compliance and ensure adherence to approved environmental procedures and performance standards.
- Developing and delivering structured training and awareness programmes for stakeholders on:
    - Good environmental management practices;
    - Management of general and project-specific environmental and social risks;
    - Procedures related to pre-construction, construction, operation, and decommissioning activities with environmental interaction;
    - Integrated waste management principles applicable to LPG facilities.
- Identifying, designating, and enforcing environmental "no-go" zones to protect sensitive receptors and prevent unacceptable environmental disturbance.

7.3 MANAGEMENT COMMITMENT AND RESPONSIBILITY

Management commitment to effective environmental, health, and safety performance for the proposed project is articulated through ZAGR's established Health, Safety and Environment (HSE) Policy. The company is fully committed to implementing this policy across all project phases pre-construction, construction, operation, and decommissioning while ensuring strict compliance with applicable national regulations, sectoral guidelines, and international best practices.

ZAGR requires all employees, contractors, and subcontractors engaged in the Birnin Kebbi Road LPG project to adhere fully to its HSE policy, irrespective of how stringent the requirements may be. This commitment is fundamental to ensuring safe operations, environmental protection, and positive community relations throughout the project lifecycle.

In line with this commitment, ZAGR shall:

- Safeguard the health, safety, and security of its employees, contractor personnel, visitors, and members of the public who may be affected by LPG facility activities.
- Prevent, reduce, and manage adverse environmental impacts associated with gas processing, compression, storage, and transportation activities.
- Demonstrate sensitivity and responsiveness to the needs, expectations, and concerns of the Birnin Kebbi Road host community and neighbouring settlements.
- Empower all staff with the right and responsibility to intervene and stop work where unsafe acts, unsafe conditions, or non-compliance with HSE requirements are observed.
- Ensure that customers, partners, visitors, and other stakeholders operating within the facility comply with ZAGR's HSE standards and procedures.
- Integrate health, safety, and environmental considerations into all aspects of project planning, design, construction, and operations, with clear objectives aimed at continuous performance improvement.
- Comply with all relevant national laws, regulations, and applicable international standards governing health, safety, and environmental protection in gas-related projects.
- Establish and maintain effective internal and external communication mechanisms on HSE matters involving employees, contractors, regulators, and host communities.
- Apply sound engineering standards, best industry practices, and risk management principles to ensure the safety, integrity, reliability, and efficiency of the LPG plant infrastructure.
- Demonstrate responsible corporate leadership by maintaining high HSE performance standards and publicly reporting environmental and safety performance where required.
- Identify existing and potential HSE hazards associated with LPG operations, conduct systematic risk assessments, and implement appropriate control measures.

- Develop and implement a comprehensive HSE management system supported by clear procedures, monitoring frameworks, and performance indicators.
- Maintain adequate emergency preparedness and response capabilities to address incidents such as gas leaks, fires, explosions, or occupational accidents.
- Communicate ZAGR's HSE expectations clearly to contractors and subcontractors and ensure their compliance through supervision and contractual obligations.
- Implement a robust compliance and audit programme to verify adherence to HSE policies and EMP commitments.
- Provide sufficient human, financial, and technical resources to support effective HSE management throughout the project.
- Adopt best practices in health, safety, and environmental protection during the design, construction, and operation of the LPG facility.
- Promote ethical and socially responsible conduct by working collaboratively with regulatory agencies, host communities, and other stakeholders.
- Engage and consult with employees and other relevant parties on occupational health, safety, and environmental conditions, including the provision of occupational health services.
- Maintain functional emergency response systems to minimize the consequences of unforeseen incidents.
- Liaise with relevant government agencies on matters relating to HSE legislation, policy formulation, and regulatory compliance affecting the project.
- Periodically disclose HSE performance outcomes in line with regulatory and corporate reporting requirements.

Through these commitments, ZAGR affirms its responsibility to ensure that the Birnin Kebbi Road LPG project is implemented and operated in a manner that prioritizes safety, environmental protection, regulatory compliance, and sustainable community relations.

7.4 EMP MEASURES

The sections that follow present the framework for the Environmental Management Plans (EMPs) developed for the proposed ZAGR Liquefied Petroleum Gas (LPG) facility in Birnin Kebbi Road**.** These EMPs provide structured guidance for managing environmental and social impacts across the different phases of the project and will be expanded to include detailed procedures for implementation by project staff and contractors. The plans are designed to remain dynamic documents, subject to periodic review and update as project conditions evolve.

The environmental management measures applicable to the pre-construction, construction, operation, and decommissioning phases of the Birnin Kebbi Road LPG project are outlined in the relevant EMP matrices.

7.4.1 Flora and Fauna Management Plan

The objective of the Flora and Fauna Management Plan is to safeguard biodiversity within and around the Birnin Kebbi Road project area while also protecting project personnel from potential risks associated with local vegetation and wildlife. The plan seeks to prevent unnecessary ecological disturbance during site preparation, construction, and operation of the LPG facility, and to promote responsible environmental stewardship.

Key provisions of this plan include the following:

- Wildlife and plant species within the project area shall not be captured, harmed, removed, or deliberately disturbed by ZAGR staff, contractors, or subcontractors.
- Poaching, illegal harvesting of plants, or destruction of wildlife habitats by project personnel will not be tolerated under any circumstances.
- ZAGR shall take all reasonable steps to maintain the ecological integrity and biodiversity quality of the Birnin Kebbi Road project environment.
- Although land clearing activities may temporaZAGRy displace wildlife, any species classified as vulnerable or protected by the Ministry of Environment that is injured or trapped during site preparation shall be reported immediately to the appropriate Wildlife Division for guidance on rescue, relocation, or other conservation actions. Provision will be made for such contingencies.

- Project planning and site layout will be carried out in advance to minimize impacts on fauna, reduce flood risks, and limit the volume of vegetation and biomass removed.
- Where water abstraction is required, ZAGR shall monitor downstream aquatic habitats to ensure that withdrawals do not impose ecological stress. Where adverse effects are identified, alternative water sources such as boreholes will be developed to offset surface water use.
- The project site shall be kept clean and free of food waste or refuse that could attract wildlife and create human–animal conflict.
- Monitoring for invasive species will be undertaken to identify their presence, pathways of introduction, control methods, and effectiveness of eradication measures. Where invasive species persist, corrective actions will be implemented to address the root causes.
- To reduce pressure on local wildlife from bush-meat hunting, ZAGR shall:
    - Encourage availability of alternative protein sources within local markets;
    - Educate employees on the ecological and health risks associated with bush-meat consumption;
    - Prohibit hunting within the project area and enforce compliance;
    - Support community awareness programmes on biodiversity conservation; and
    - Promote alternative and sustainable livelihood opportunities for local hunters.
- ZAGR will collaborate with conservation agencies, community leaders, and relevant stakeholders to discourage poaching, including the use of signage, surveillance, and community-based conservation initiatives.

7.4.2 Waste Management Plan

The Waste Management Plan is designed to ensure that wastes generated by the Birnin Kebbi Road LPG project are minimized, properly handled, and disposed of in a manner that protects human health and the environment. The plan follows the waste hierarchy of prevention, reduction, reuse, recycling, treatment, and safe disposal.

The guiding principles include:

- Minimizing waste generation at source;
- Reusing or recycling materials wherever feasible;

- Treating or neutralizing wastes that cannot be reused or recycled; and
- Ensuring environmentally sound disposal of residual wastes.

Key elements of the Waste Management Plan include:

- Clear assignment of waste management responsibilities, including the appointment of a trained Waste Management Supervisor.
- Identification and documentation of all waste streams generated at the LPG facility, with estimates of quantities produced on a regular basis, particularly hazardous wastes.
- Provision of clearly labelled, colour-coded waste containers for different waste categories, housed in designated storage areas.
- Strict segregation of hazardous and non-hazardous wastes, with hazardous wastes managed in accordance with Material Safety Data Sheets (MSDS).
- Anticipated hazardous wastes will primarily include empty lubricant containers, used oils and greases, oil-contaminated rags, and absorbent materials.
- Mixing of hazardous wastes shall be prohibited unless explicitly approved within the plan.
- Engagement of only licensed and accredited waste contractors, with valid certification confirming legal operation.
- Use of accredited contractors for specific waste streams, including:
    - Used oil recycling;
    - Lead and battery recycling;
    - Scrap metal, tyres, rubber, and plastics recycling;
    - Electronic waste handling;
    - High-temperature hazardous waste incineration; and
    - Domestic waste collection.
- Tracking of hazardous waste movement using Waste Manifest Forms, with records retained for regulatory review.
- Periodic reconciliation of estimated and actual waste quantities to identify discrepancies.
- Routine inspections of waste handling practices to ensure compliance with EMP requirements.

7.4.3 Erosion and Sedimentation Management Plan

The Erosion and Sedimentation Management Plan provides guidance for preventing soil erosion and controlling sediment transport during land clearing, site preparation, and construction activities at the Birnin Kebbi Road LPG facility. Soil erosion poses a risk to soil fertility, drainage systems, and downstream water quality if not adequately managed.

All exposed soil surfaces within the project area shall be managed using a combination of engineering and biological controls aimed at reducing runoff velocity, retaining sediments, and preventing off-site impacts. The effectiveness of these measures will be monitored through routine inspections and downstream water quality assessments, including turbidity checks.

Key erosion and runoff control measures include:

- Preservation of vegetated buffer zones along natural drainage channels and streams.
- Use of cover crops and temporary vegetation to protect exposed soil and improve soil structure.
- Phased and progressive site clearing to avoid large areas of bare soil.
- Installation of temporary erosion control measures such as silt fences, sediment traps, and check dams where permanent controls are not yet in place.
- Proper grading and shaping of cut and fill slopes to approved design limits.
- Direction of stormwater over controlled flow paths using berms, channels, and energy-dissipation structures.
- Temporary protection of exposed surfaces using mulch, geotextiles, plastic sheeting, or similar materials when required.
- Long-term stabilization through terracing, re-vegetation, and slope protection measures.
- Use of riprap or concrete protection around culverts and drainage outlets.
- Construction of stormwater inlets and drainage structures designed to safely convey runoff during design storm events.
- Controlled placement of soil stockpiles on flat areas away from drainage paths, with topsoil stockpiles protected against erosion.
- Maximum utilization of natural drainage systems, with open channels preferred over buried pipes wherever practicable.

7.4.4 Employment, Training, and Awareness Management Plan

The Employment, Training, and Awareness Management Plan is a critical component of the Environmental Management Plan for the proposed LPG facility in Birnin Kebbi Road and will be implemented during both the construction and operational phases of the project. The plan is designed to ensure that all workers are adequately trained, informed, and aware of their environmental, health, and safety responsibilities while carrying out LPG-related activities.

During employee induction, all personnel will undergo mandatory health and safety orientation covering standard operating procedures, hazard identification, emergency response, and LPG-specific risks. In addition, workers deployed at active work fronts will participate in weekly toolbox talks and safety briefings**,** each lasting not less than 15 minutes. These sessions will be intensified following any incident, near-miss, or emerging health and safety concern.

Records of all training activities will be maintained to track worker competence and compliance. Training requirements will be detailed in an Integrated Health and Safety Plan (IHSP)**,** which will define training content, target groups, delivery frequency, and evaluation methods. Core training modules will include:

- General health and safety induction;
- Community relations and code of conduct;
- Basic first aid and emergency response;
- Awareness of venomous or dangerous animals;
- Proper use of personal protective equipment (PPE); and
- Safe work procedures specific to LPG handling and operations.

7.4.5 Water Management Plan

The Water Management Plan for the Birnin Kebbi Road LPG project is intended to promote efficient water use, protect surface and groundwater resources, and prevent pollution throughout the project lifecycle. The plan recognizes the importance of water for domestic use, agriculture, and ecosystem sustainability in the host community.

Key elements of the plan include:

- Training all project personnel on the importance of conserving and protecting water resources;
- Implementing erosion and sediment control measures to prevent siltation and nutrient loss into surface water bodies;
- Applying waste management controls to prevent contamination of surface water and groundwater from liquid effluents or leachate;
- Periodic monitoring of significant effluent streams to ensure compliance with FMEnv discharge standards;
- Establishing a site-specific water quality monitoring programme for surface water and groundwater;
- Monitoring downstream water availability to ensure that project water use does not negatively affect other users; and
- Ensuring that any boreholes or water abstraction facilities comply with national standards and do not adversely affect existing groundwater users.

7.4.6 Vegetation Clearing and Biomass Management Plan

The Vegetation Clearing and Biomass Management Plan provides procedures for managing land clearing and biomass generated during site preparation and infrastructure development for the Birnin Kebbi Road LPG facility. The plan ensures compliance with FMEnv requirements and aims to minimize ecological disturbance.

Uncontrolled vegetation clearing may result in habitat loss, biodiversity reduction, and soil degradation. To prevent this, ZAGR will avoid areas of high conservation value and apply environmentally responsible clearing practices. The plan will include procedures for:

- Clearly defining areas approved for clearing and areas designated for protection;
- Applying clearing methods that allow wildlife to escape from disturbed zones;
- Ensuring optimal utilization of merchantable timber where applicable;
- Allowing local communities reasonable access to non-timber forest products prior to or immediately after clearing;
- Managing, reusing, or safely disposing of biomass generated during clearing activities.

This plan will be implemented alongside the Employment, Training and Awareness Plan and the Erosion and Sedimentation Management Plan to ensure worker safety, environmental protection, and community wellbeing.

7.4.7 Air Quality Management Plan

The Air Quality Management Plan aims to control emissions and noise associated with construction and operation of the Birnin Kebbi Road LPG facility, thereby safeguarding ambient air quality and community health.

Key measures include:

- Ensuring that noise levels during construction and operation comply with Nigerian regulatory limits;
- Using modern, well-designed LPG storage and processing equipment to minimize emissions of nitrogen oxides (NOx) and other air pollutants;
- Maintaining all project vehicles and machinery in good working condition and fitting them with appropriate emission control devices;
- Avoiding the use of ozone-depleting substances in cooling systems, cleaning agents, or other operational processes.

7.4.8 Emergency Response and Incident Management Plan

The Emergency Response and Incident Management Plan establishes procedures for managing foreseeable emergencies related to LPG operations, including fires, gas leaks, chemical spills, flooding, medical emergencies, and extreme weather events.

The plan defines responsibilities, communication protocols, and resource requirements to ensure rapid and effective response in order to protect workers, the public, property, and the environment. Relevant emergency services and regulatory authorities will be notified promptly in the event of a serious incident.

Spill management procedures will address accidental releases that may occur during fuel transfer, equipment maintenance, refuelling, container handling, or as a result of equipment failure or traffic accidents involving LPG tankers. The plan will:

- Identify responsible personnel and emergency contacts;
- Establish a structured spill response organization;
- Characterize potential spill materials and quantities;
- Define response procedures, equipment, and PPE requirements;
- Provide training for spill containment, recovery, and waste disposal; and
- Include dZAGRls and refresher training to maintain readiness.

7.4.9 Traffic and Vehicle Management Plan

The Traffic and Vehicle Management Plan is designed to minimize road safety risks, noise, dust, and traffic disruption associated with LPG transportation activities in Birnin Kebbi Road and surrounding communities.

The plan will include:

- Installation of speed limits and appropriate road signage along project access routes;
- Strict enforcement of speed limits within the project site and nearby communities;
- Mandatory road safety training for all project drivers;
- Routine inspection and maintenance of all vehicles to ensure roadworthiness and safety compliance.

7.4.10 Health, Safety, and Security Management Plan

The Health, Safety, and Security Management Plan for the Birnin Kebbi Road LPG project will comply with national regulations and international best practices. The plan addresses workplace hygiene, occupational safety, security arrangements, and continuous training for employees.

Key provisions include:

- Provision and mandatory use of appropriate PPE such as helmets, gloves, safety boots, respirators, eye and hearing protection;

- Job-specific risk assessments to determine PPE requirements;
- Training on proper use of equipment and enforcement of safety rules;
- Installation of physical barriers to restrict unauthorized access to hazardous areas;
- Specialized training on electrical, mechanical, lifting, welding, and vehicle-related hazards;
- Availability of trained first aid personnel, a well-equipped treatment room, and ambulance services for emergency response.

7.4.11 Community Health and Safety Plan

The Community Health and Safety Plan addresses potential impacts of the Birnin Kebbi Road LPG project on nearby communities. Construction activities may attract job seekers and service providers, which can increase social risks such as crime or public health challenges.

Mitigation measures include:

- Prioritizing recruitment of local labour to reduce influx of non-local workers;
- Enforcing worker codes of conduct to discourage involvement in drugs, alcohol abuse, or commercial sex;
- Sensitizing communities on potential social risks associated with project activities;
- Implementing community health awareness programmes in collaboration with health authorities;
- Monitoring public health indicators to identify and address emerging risks.

7.4.12 Stakeholder Engagement Plan

Stakeholder engagement has been integrated into the Birnin Kebbi Road LPG project from inception. The Stakeholder Engagement Plan provides a structured approach for identifying stakeholders, conducting consultations, and maintaining open communication throughout the project lifecycle.

The plan includes:

- Identification and mapping of key stakeholders;

- Documentation of previous consultations;
- Ongoing engagement during construction and operation;
- Allocation of resources for stakeholder engagement;
- Monitoring and reporting on engagement outcomes.

A Grievance Redress Mechanism (GRM) will allow individuals or groups to submit complaints in person, by phone, or electronically. All grievances will be documented, investigated, and resolved promptly, transparently, and at no cost to the complainant.

7.4.13 Decommissioning Plan

The Decommissioning Plan outlines the approach for eventual closure of the Birnin Kebbi Road LPG facility. Although decommissioning is not anticipated in the near term, the plan will be periodically updated as the project matures.

The plan will address:

- Workforce disengagement and retrenchment procedures;
- Possible transfer or conversion of project infrastructure for community or alternative use;
- Capacity building and skills training for affected employees; and
- Restoration of the project site to environmentally acceptable conditions, including re-vegetation or alternative land use as appropriate.

Table 7.1: Environmental Management Plan (EMP) of the LPG Plant (Pre-Construction phase)

Activity	Environmental/Social Aspect	Mitigation Measure	Monitoring Indicator	Frequency	Responsible Party
Land acquisition	Displacement, loss of land/livelihood	Fair compensation, livelihood restoration, community engagement	Grievance records, payment receipts	One-off	ZAGR, FMEnv, SASEPA
Influx of job seekers	Pressure on services, tension	Local hiring policy, pre-employment screening, camp setup	% local hires, site congestion	Monthly	ZAGR, HR/Community Liaison
Site clearing and bush removal	Biodiversity loss, erosion	Limit clearing, revegetation, buffer zones	Cleared area size, erosion markers	Weekly	ZAGR, Contractor
Site survey and geotechnical work	Soil compaction, noise	Controlled equipment use, work hour limits	Community complaints, decibel readings	Weekly	ZAGR, HSE Unit
Equipment mobilization	Traffic safety, emissions	Route planning, signage, trained drivers	Road incidents, logbook entries	Weekly	ZAGR, Traffic Safety Officers
Waste generation	Littering, unmanaged debris	Site waste bins, contract waste disposal	Waste volume log, cleanup records	Weekly	ZAGR, Waste Contractor

Table 7.2: Environmental Management Plan (EMP) of the LPG Plant (Construction Phase)

Activity	Environmental/Social Aspect	Mitigation Measure	Monitoring Indicator	Frequency	Responsible Party
Civil works (earthworks, roads)	Erosion, sedimentation	Watering, silt traps, scheduling during dry weather	Turbidity of runoff, sediment trap logs	Bi-weekly	Contractor, ZAGR HSE Unit
Equipment operation	Noise, air emissions	Routine maintenance, noise barriers	Noise levels, equipment inspection logs	Weekly	Contractor, ZAGR
welding and piping	Fire risk, fumes	Fire extinguishers, hot work permits	Permit-to-work records, PPE use	Daily	ZAGR Safety Officer
Hydro testing of tanks/pipes	Contamination by test water	Treat test water, reuse when possible	pH, BOD, test water disposal log	Per activity	Contractor, HSE Unit
Generator/fuel use	GHG, noise, spills	Emission control, spill kits	Generator logs, emission test results	Monthly	ZAGR, Environmental Officer
Waste from construction	Unmanaged debris, pollution	Sort at source, contract disposal	Waste manifests, on-site inspection	Weekly	ZAGR, Waste Contractor
Site safety during works	Injuries, OHS breaches	Enforce PPE, daily toolbox talks	Incident reports, HSE audits	Daily	HSE Supervisor

Table 7.3: Environmental Management Plan (EMP) of the LPG Plant (Operation Phase)

Activity	Environmental/Social Aspect	Mitigation Measure	Monitoring Indicator	Frequency	Responsible Party
LPG unloading & handling	Explosion/fire risk	Pressure relief valves, detectors, ESD system	LEL monitor logs, emergency drill reports	Monthly	ZAGR Engineering Unit
Compressor and pump operations	Noise, mechanical failure	Acoustic enclosure, routine maintenance	Noise level logs, maintenance records	Monthly	ZAGR Technical Unit
Generator operation	Emissions, fuel leaks	Low-emission equipment, bund walls	Air quality readings, fuel usage logs	Quarterly	ZAGR, Environmental Unit
Cylinder/skid filling	Fire/explosion risk	Level gauges, operator training	Inspection checklists, event log	Weekly	ZAGR, Fire & Safety Team
Waste handling	Improper disposal	Secure storage, licensed haulers	Waste manifest, visual inspection	Monthly	ZAGR, Waste Contractor
Community relations	Expectations, complaints	Grievance redress mechanism, CSR projects	Complaints log, CSR report	Quarterly	ZAGR Community Desk

Table 7.4: Environmental Management Plan (EMP) of the LPG Plant (Decommissioning Phase)

Activity	Environmental/Social Aspect	Mitigation Measure	Monitoring Indicator	Frequency	Responsible Party
Planning and communication	Unrest, resistance	Stakeholder engagement plan	Meeting records, response time	Monthly	ZAGR, FMEnv, SASEPA
Equipment dismantling	Occupational injuries	Enforce OHS protocols, use experienced contractors	Injury reports, HSE compliance checks	Daily	Contractor, ZAGR
Waste removal (scrap, liquids)	Pollution from residuals	Identify hazards, use authorized recyclers/disposal vendors	Waste manifest, disposal receipts	Weekly	ZAGR, Certified Contractor
Site restoration	Soil compaction, landscape disruption	Regrade land, plant grass/native species	Site inspection, restoration photos	End of works	Contractor, ZAGR
Disengagement of workers	Community conflict	Early notice, exit packages, alternative opportunities	Complaints log, redundancy reports	One-off	ZAGR HR/Community Liaison

7.5 ENVIRONMENTAL AUDIT PROGRAMME

An environmental audit will be undertaken before project mobilization and at scheduled intervals during the construction and operational phases of the proposed LPG facility in Birnin Kebbi Road. The audit process will serve as a management tool for evaluating environmental performance and ensuring that the project is implemented in line with the principles of sustainable development and applicable regulatory requirements.

The environmental audit will focus on verifying that appropriate management systems and control measures are in place and functioning effectively throughout the lifecycle of the LPG project. Specifically, the audit will aim to:

- assess the level of compliance with relevant environmental laws, guidelines, and permit conditions applicable to LPG operations;
- examine facility management systems, operational procedures, and environmental monitoring practices;
- identify existing and potential environmental issues that may arise during the preconstruction, construction, and operational phases of the project;
- confirm the effective implementation of recommended mitigation measures and management procedures outlined in the EIA and EMP; and
- provide practical recommendations for strengthening and improving the environmental management system of the Birnin Kebbi Road LPG project.

Findings from the audits will be documented and used to support continuous improvement in environmental performance.

7.6 ENVIRONMENTAL MONITORING

Environmental monitoring will be an integral part of the Environmental Management Plan for the Birnin Kebbi Road LPG project, aimed at tracking project impacts and ensuring compliance with environmental standards throughout project implementation.

The objectives of environmental monitoring include:

- verifying that mitigation measures are implemented as prescribed in the EIA report and other relevant project documents;
- providing early warning signals for incidents such as accidents, gas leaks, or equipment failures, thereby enabling timely response to prevent or minimize adverse environmental and safety impacts;
- detecting the occurrence of environmental impacts and assessing their extent and magnitude; and
- ensuring that emissions, effluents, and waste generated from LPG-related activities remain within permissible regulatory limits.

Two major types of environmental monitoring will be adopted for the project:

Impact Monitoring

This will involve monitoring environmental parameters that may be affected by LPG construction and operational activities. Key variables will include:

- flora and fauna;
- soil quality and stability;
- surface water quality and sediment characteristics;
- ambient air quality and noise levels within and around the project area.

Compliance Monitoring

Compliance monitoring will be carried out through periodic sampling and, where necessary, continuous measurement of emissions, effluents, noise, and other discharges from the LPG facility. This will ensure that all environmental parameters consistently meet standards prescribed by FMEnv and other relevant regulatory authorities.

Table 7.5: Environmental Monitoring Programme

S/N	Environmental Component	Parameters to be Monitored	Sampling Location	Frequency	Responsible Party	Estimated Cost (₦)
1	Air Quality	PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, H_2S	Tanker bay, Generator area, Site perimeter	Monthly	ZAGR, FMEnv, Consultant	250,000 /month
2	Noise Level	Day & Night dB(A) levels	Generator area, Site boundary	Monthly	ZAGR, SJASEPA, HSE Officer	150,000 /month
3	Groundwater Quality	pH, EC, TDS, Heavy metals, Hydrocarbons	Nearest borehole, Monitoring well near fence line	Quarterly	ZAGR, Consultant	300,000 /quarter
4	Surface Water Quality	DO, BOD_5, COD, Oil & Grease, TSS	Atabrikang Stream (upstream & downstream)	Quarterly	ZAGR, Consultant, FMEnv	350,000 /quarter
5	Soil Quality	pH, Heavy metals, Hydrocarbon content	Storage area, pre-cleared area	Quarterly	ZAGR, Environmental Consultant	300,000 /quarter
6	Vegetation & Biodiversity	Species composition, habitat integrity	Buffer zones, disturbed areas	Bi-annually	ZAGR, Biodiversity Expert	500,000 /assessment
7	Socioeconomic Conditions	Grievances, employment levels, CSR implementation	Atabrikang &Dawakin Kudu host community	Quarterly	ZAGR, Community Liaison Officer	200,000 /quarter
8	Occupational Health & Safety	PPE usage, accidents/incidents, first aid readiness	LPG loading area, Generator station	Monthly	ZAGR, Safety Officer	100,000 /month
9	GHG Emissions	CO_2 equivalent from generators & vehicles	Generator/Logistics logbook	Quarterly	ZAGR, Environmental Consultant	250,000 /quarter
10	Waste Management	Waste quantity, type, treatment and disposal log	Site waste storage area	Monthly	ZAGR, Licensed Waste Contractor	200,000 /month

CHAPTER EIGHT

DECOMMISSIONING AND ABANDONMENT PLAN

8.1 INTRODUCTION

Projects are typically planned and implemented with a defined operational lifespan, during which they are expected to deliver their intended benefits before eventual decommissioning and abandonment at the end of their useful life. In some cases, the actual lifespan of a project may be shorter than anticipated, while in others it may be extended through effective planning, regular maintenance, and technological upgrades.

The sustainability and longevity of the proposed LPG facility in Birnin Kebbi Road will largely depend on several key factors, including:

- the availability of appropriate equipment and spare parts;
- the durability and performance of installed machinery and infrastructure;
- the economic viability and profitability of the project; and
- the continued usefulness, safety, and acceptance of LPG as an end-product by consumers.

Petroleum-related facilities, including Liquefied Petroleum Gas plants, gas storage systems, pipelines, and associated infrastructure, are generally designed with an operational lifespan of approximately 30 years. Over time, technological advancements, regulatory changes, or declining economic returns may render such facilities obsolete or commercially unviable. In addition, as the project relies on non-renewable hydrocarbon resources, it is inevitable that the facility will reach a point where continued operation is no longer sustainable.

When this stage is reached, the project proponent will be required to implement a comprehensive decommissioning and abandonment programme for the Birnin Kebbi Road LPG facility. This programme will be designed and executed to ensure that all installations are safely dismantled, potential environmental and social risks are minimized, and the project site is restored in an environmentally responsible manner in line with applicable national regulations and best international practices.

8.2 DECOMMISSIONING / ABANDONMENT PLAN

Decommissioning refers to the orderly shutdown, dismantling, and final disposal of the Liquefied Petroleum Gas (LPG) facility in Birnin Kebbi Road and its associated infrastructure at the end of its operational lifespan or in the event that the project proponent withdraws from LPG-related operations. At this stage, all project components will be safely removed, and the site restored to an environmentally acceptable condition.

During the decommissioning phase, the project proponent shall ensure that all facilities are dismantled in a controlled manner, followed by appropriate site demolition and soil remediation**.** Contractors engaged for this phase will establish effective and efficient waste management systems to handle all forms of waste generated. Decommissioning wastes, including excavated soil, construction debris, metal scraps, and other materials, will be managed through backfilling, recycling, or disposal at locations approved by relevant regulatory authorities**.**

To ensure occupational safety and environmental protection, targeted capacity building and training programmes will be provided for all workers and staff involved in the decommissioning activities. These programmes will focus on identifying potential hazards, adopting preventive measures, and complying with approved safety procedures to minimize accidents and environmental risks.

The proponent, in consultation with relevant regulatory agencies such as the Federal Ministry of Environment (FMEnv), Nigerian Upstream Petroleum Regulatory Commission (formerly DPR), Sokoto State Environmental Protection Agency (KASEPA)**,** and the Birnin Kebbi Road host community, will implement a comprehensive site remediation plan. This will ensure that affected soils and the entire project site are restored, as far as practicable, to their pre-project environmental condition**.**

8.3 DECOMMISSIONING / ABANDONMENT PROCESS

At the end of the operational life of the Birnin Kebbi Road LPG facility, decommissioning activities will be carried out in accordance with approved environmental and safety standards and shall include the following:

- All installed LPG facilities and associated infrastructure will be carefully dismantled and removed to enable effective remediation of the project site.

- Storage tanks, vessels, and pipelines will be safely drained following standard procedures. Residual gas and liquids will be evacuated through approved pumping and vaporization methods.
- The proponent's Health, Safety and Environmental (HSE) Management System will be strictly implemented to protect workers, the public, and the environment during the decommissioning process.
- All surface structures, buildings, and foundations will be dismantled and transported to approved disposal or recycling facilities.
- Reusable and recyclable components, including metals and mechanical parts, will be identified, segregated, and quantified for reuse or recycling.
- Utility connections such as water supply and power lines will be safely disconnected and removed once decommissioning is completed.
- Cleared areas will be re-vegetated using fast-growing indigenous plant species suitable for the Birnin Kebbi Road environment.
- All disturbed areas within the project site will be rehabilitated and restored using appropriate soil stabilization and revegetation techniques.
- Any contaminated environmental media (soil or surface water) attributable to LPG operations will be remediated to acceptable regulatory standards.

Table 8.1 Decommissioning Mitigation Matrix for the Birnin Kebbi Road LPG Project

Decommissioning Activity	Potential Impact	Mitigation Measures	Responsibility	Monitoring Indicator
Dismantling of LPG facilities and equipment	Soil disturbance, dust generation	Controlled dismantling; wetting of surfaces to suppress dust	Project Proponent / Contractor	Visual inspection; dust levels
Draining and removal of gas tanks and pipelines	Gas leakage, fire or explosion risk	Adherence to standard tank draining procedures; gas detection systems; fire safety equipment on site	Contractor / HSE Officer	Zero gas leakage incidents

Decommissioning Activity	Potential Impact	Mitigation Measures	Responsibility	Monitoring Indicator
Removal of surface structures	Noise, vibration, solid waste generation	Use of appropriate machinery; work limited to daytime; proper waste segregation	Contractor	Noise levels within permissible limits
Handling of dismantled materials	Environmental pollution	Segregation of recyclable and non-recyclable materials; recycling where possible	Contractor	Waste records and disposal receipts
Disposal of excavated soil and debris	Land degradation, improper dumping	Disposal at regulatory-approved sites; backfilling of excavated areas	Contractor / KASEPA	Approved disposal certificates
Site clearance and remediation	Loss of vegetation, soil erosion	Soil stabilization and re-vegetation with native species	Project Proponent	Vegetation regrowth rate
Worker activities during decommissioning	Occupational health and safety risks	HSE training, use of PPE, emergency preparedness	Contractor / HSE Officer	Accident/incident records
Final site restoration	Residual contamination	Soil testing and remediation to regulatory standards	Proponent / Regulators	Soil quality compliance results

CHAPTER NINE

CONCLUSION

This Environmental Impact Assessment (EIA) for the proposed 200 metric tons Liquefied Petroleum Gas (LPG) storage and refilling plant by Zamson Global Resources Limited, to be located opposite the Airport along Birnin Kebbi Road in Bodinga Local Government Area of Sokoto State, presents a comprehensive evaluation of the potential environmental, social, economic, and public health implications associated with the project. The assessment covered all phases of the project lifecycle, including site preparation, construction, operation, and decommissioning, with particular emphasis on key environmental components such as air quality, soil characteristics, groundwater protection, ambient noise levels, traffic conditions, occupational health and safety, and community wellbeing within the defined area of influence.

The findings of the study indicate that although certain impacts may arise—such as emissions from operational activities, risks of accidental gas leakage, noise generation, increased vehicular movement, and waste generation—these impacts are not expected to be significant when appropriate mitigation measures are effectively implemented. The Environmental Management Plan (EMP) developed for this project provides detailed strategies for impact prevention, control, monitoring, and emergency response. With strict adherence to these measures, all identified impacts can be minimized to acceptable levels in compliance with national environmental standards and internationally recognized best practices for LPG facilities.

Zamson Global Resources Limited has demonstrated strong commitment to environmental protection and regulatory compliance by aligning the project with the requirements of the Federal Ministry of Environment (FMEnv), the National Midstream and Downstream Petroleum Regulatory Authority (NMDPRA), and relevant Sokoto State environmental regulations. In addition, the adoption of established safety standards for LPG storage, handling, and distribution will ensure adequate protection of workers, host communities, and surrounding infrastructure.

The successful implementation of the proposed LPG facility will depend on sustained collaboration among the project proponent, contractors, regulatory agencies, traditional institutions, and host communities within Bodinga LGA. Continuous stakeholder engagement, regular environmental monitoring, workforce training, and the establishment of an effective grievance redress mechanism will be critical in maintaining transparency, addressing concerns promptly, and strengthening community trust throughout the project lifecycle.

From a developmental perspective, the project is expected to significantly enhance the availability and accessibility of LPG within Sokoto metropolis and surrounding areas, thereby promoting the use of cleaner and more efficient energy sources. This will contribute to a reduction in dependence on firewood and other biomass fuels, leading to decreased deforestation, improved air quality, and better public health outcomes. Furthermore, the project will stimulate socio-economic growth through direct and indirect employment opportunities, support for local businesses such as transporters and cylinder distributors, and increased commercial activities along the Birnin Kebbi Road corridor.

Provisions for decommissioning have also been integrated into the project design. At the end of its operational life, the facility will be safely dismantled, wastes properly managed, and the site rehabilitated in accordance with environmental standards to prevent long-term ecological impacts.

In conclusion, the proposed 200MT LPG storage and refilling plant by Zamson Global Resources Limited in Bodinga LGA represents a strategic and sustainable energy infrastructure project that effectively balances economic development with environmental stewardship. Provided that the Environmental Management Plan is fully implemented and regulatory oversight is maintained, the project is considered environmentally acceptable, socially beneficial, and capable of contributing meaningfully to clean energy transition and sustainable development in Sokoto State and Nigeria at large.

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APPENDIX I

PROPOSED LPG REFILLING STATION IN BODINGA, SOKOTO STATE

SOCIOECONOMIC ASSESSMENT INSTRUMENTS

HOUSEHOLD QUESTIONNAIRE

DEMOGRAPHY

1. Age ……
2. Sex ……....
3. Academic qualification ……
4. Marital status ……
5. Family type …….....
6. Household size ……..……

SOCIO-ECONOMIC

7. What is your occupation? …….....
8. What are your other means of livelihood? ……..
9. What is your average monthly income? (Less than 10,000) (11,000-30,000) (31,000-50,000) (above 50,000)
10. What is your average cost of living/ month? …….
11. Do you live in your own house or on rent? ……

SOCIAL INFRASTRUCTURE

12. Where do you source your drinking water from? ……..
13. What is the distance from your household to your source of water? ……
14. What is the source of your domestic power supply? ……
15. What fuel do you use for cooking/heating? ……..
16. Is there telecommunication services in your community? ……
17. What is the mode of transportation in your community? ……..

WASTES MANAGEMENT

18. What is the major source of domestic waste? …….
19. How do you manage your household waste? ……..
20. How do you dispose of human waste? …….
21. What kind of toilet facility do you have? ……

PROJECT AWARENESS/ IMPACT

22. Are you aware about the LPG refilling Plant project? ……

23. Do you think the coming of the project will affect your livelihood? …….
24. Do you think the coming of the project will alter your culture and norms? ……..
25. What are your expectation from the LPG refilling Plant company?
……
…….
26. What are your fears about the LPG refilling Plant project?
……
…….

KEY INFORMANT INTERVIEW GUIDE

GENERAL INFORMATION

1. Name of local leader/ phone number?
   …….....
2. What post do you hold in the community? ……..
3. What is the name of the leader in this community? ……..……...
4. What are the predominant tribes and languages spoken? .....

……...

5. What is the average number of household size?
   ……..
6. Are there sacred animals/monuments or sites in this community?
   ……..

……...

7. Is there any cultural heritage artifacts or site within or close to the proposed LPG refilling Plant site?
   ……...
8. What are regarded as taboos in this community?
   …….

.....

9. Is this community your ancestral land? ……....
10. What is your relationship with visitors like? ……
11. Share brief community history …….

ECONOMIC INFORMATION

12. What are the means of livelihood here?

	MEN	WOMEN	YOUTHS
1			
2			
3			

13. What are the common crops farmed here?
    ……...
14. What domestic livestock do you keep around here?
    ……

……...

15. What species of wildlife exist in this community?
    ….....

COMMUNITY POLITICS

16. What is the method of selecting the Traditional Ruler?
    ……...

……...

……...

17. What is the hierarchy of leadership like here?
……
.....

18. Do women participate in decision making here? …….
19. Are women free to engage in politics outside the community? ……...
20. How are disputes settled? …….
21. Are there any social organisations within the community?
…….....

22. Are there any community conflicts?
……
……...

HEALTH IMPACT

23. What are the major sicknesses suffered in this community?
……
……...

24. Where do you get medical attention from? (health facility and address)
……...…

25. Are there any alternatives to orthodox treatments? (probe for patronage)
……...

26. Why do you think people don't seek for orthodox medical attention?
……
……...

27. Have you lost any family member in the last two years? (what was the of cause of death?)
…….....

…….....

PROJECT INFORMATION AND IMPACT

19. Are you aware of this project? .....……..
20. How do you think it will benefit this community? .....
……

21. Do you have any fears at all with this project? (mention these fears?) ……...
22. Any other information……..
……

EDUCATION

23. Do you have schools in this community?

SN	SCHOOLS	NAMES
1	Primary	
2	Secondary	
3	Tertiary	
4	Others	

FOCUS GROUP DISCUSSION

Name of community…… **LGA**……**Date**...……

Time….. **Men Group**

1. Are you aware of the proposed LPG refilling Plant project?.....
2. What is your perception on the proposed project? ……..
3. How has the LPG refilling Plant affected you in the past?
   ……..
4. What is the major means of livelihood here? ……..
5. Do you think this LPG refilling Plant project will affect your livelihood in any way?.....
6. Do you have any fears about the project?
……... If yes. What are your fears?
……..
7. What can be done to ease these fears? ……
8. What are the prevalent diseases in this community? ……..
9. What are the three major needs of this community? ……...
10. Any other useful information ……

Women Group

1. Are you aware of the proposed LPG refilling Plant project?.....
2. What is your perception on the proposed project? ……..
3. How has the LPG refilling Plant affected you in the past?
   ……..
4. What is the major means of livelihood here? ……..
5. Do you think this LPG refilling Plant project will affect your livelihood in any way?.....
6. Do you have any fears about the project?
……... If yes. What are your fears?
……..
7. What can be done to ease these fears? ……
8. What are the prevalent diseases in this community? ……..
9. What are the three major needs of women in this community? ...……...
10. What roles do women play in this community? ……
11. Are women involved in LPG refilling Plant in this community?
    …….
12. Do women hold leadership positions? (mention them) …….
13. Are women allowed to take decisions within the family? …….
15. How will this project benefit women? ……..

15. Will this project affect women's participation in LPG refilling Plant in this community?

……..

16. Are there peculiar challenges facing women in this community? …….
17. Do you envisage any fear about the project? ……
18. What specific health challenges face women? ……..
19. Where do you obtain treatment? ……...
20. Does/do these centres provide enough services for you and the children? .....
21. What are your specific needs? ……...
22. Any other useful information ……
……..

Youth Group

1. Are you aware of the proposed LPG refilling Plant project?.....
2. What is your perception on the proposed project? ……..
3. How has the LPG refilling Plant affected you in the past?
   ……..
4. What is the major means of livelihood here? ……..
5. Do you think this LPG refilling Plant project will affect your livelihood in any way?.....
6. Do you think this LPG refilling Plant project will have any benefit to the youths of this community:
7. Do you have any fears about the project?
   ……... If yes. What are your fears? ……..
8. What can be done to ease these fears? ……
9. What are the prevalent diseases in this community? ……..
10. What are the three major needs of this community? ……
11. Any other useful information ……

3D QUESTIONNAIRE FOR HEALTH CENTRES

1. Name of Centre……
2. Year of establishment ……
3. Capacity of centre……
4. Hierarchy of centre
   a. Teaching Hospital [ ]
   b. Specialist Hospital [ ]
   c. General Hospital [ ]
   d. Primary Health Care Centre [ ]
   e. Midwife/Clinic [ ]
5. Ownership status of centre
   a. Public [ ]
   b. Private [ ]
6. Staff strength of centre ……

7. What basic services are rendered in the centre? .....
8. Is the centre accessible to patients? ……
9. As a LPG refilling Plant community, what diseases are most prominentt in this community? ..... Children:
   ……
   …. Women:
   ……
   ….. Pregnant Women:
   ……
   Male Adult:
   ……
   .
10. Which of the mentioned diseases is mostly responsible for mortality?
    …….. Children:
    Women:

    Pregnant Women:

    Male Adult:

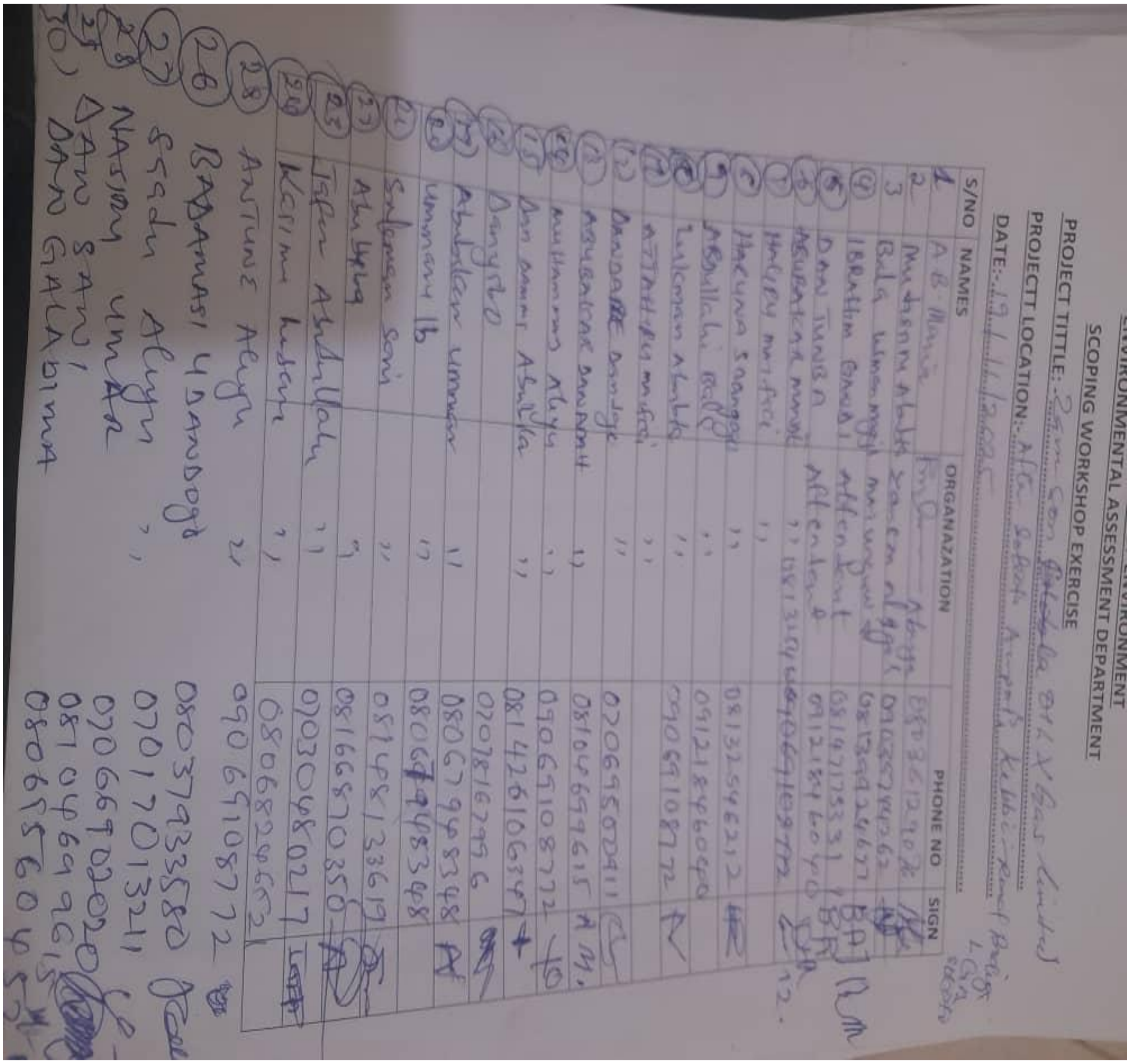
11. Is there any centre attached to you for referral?
    .....
    .....

    .....

12. Do patients come here at the onset of an ailment or when it is already advanced?
    ……
    ……
13. What are the challenges of the centre?
    ……
    ……

APPENDIX II

ATTENDANCE AT SITE VERIFICATION AND DATA GATHERING EXERCISE


ENVIRONMENTAL ASSESSMENT DEPARTMENT

SCOPING WORKSHOP EXERCISE

PROJECT TITTLE:- 2am Son Petroleum Oil & Gas Limited

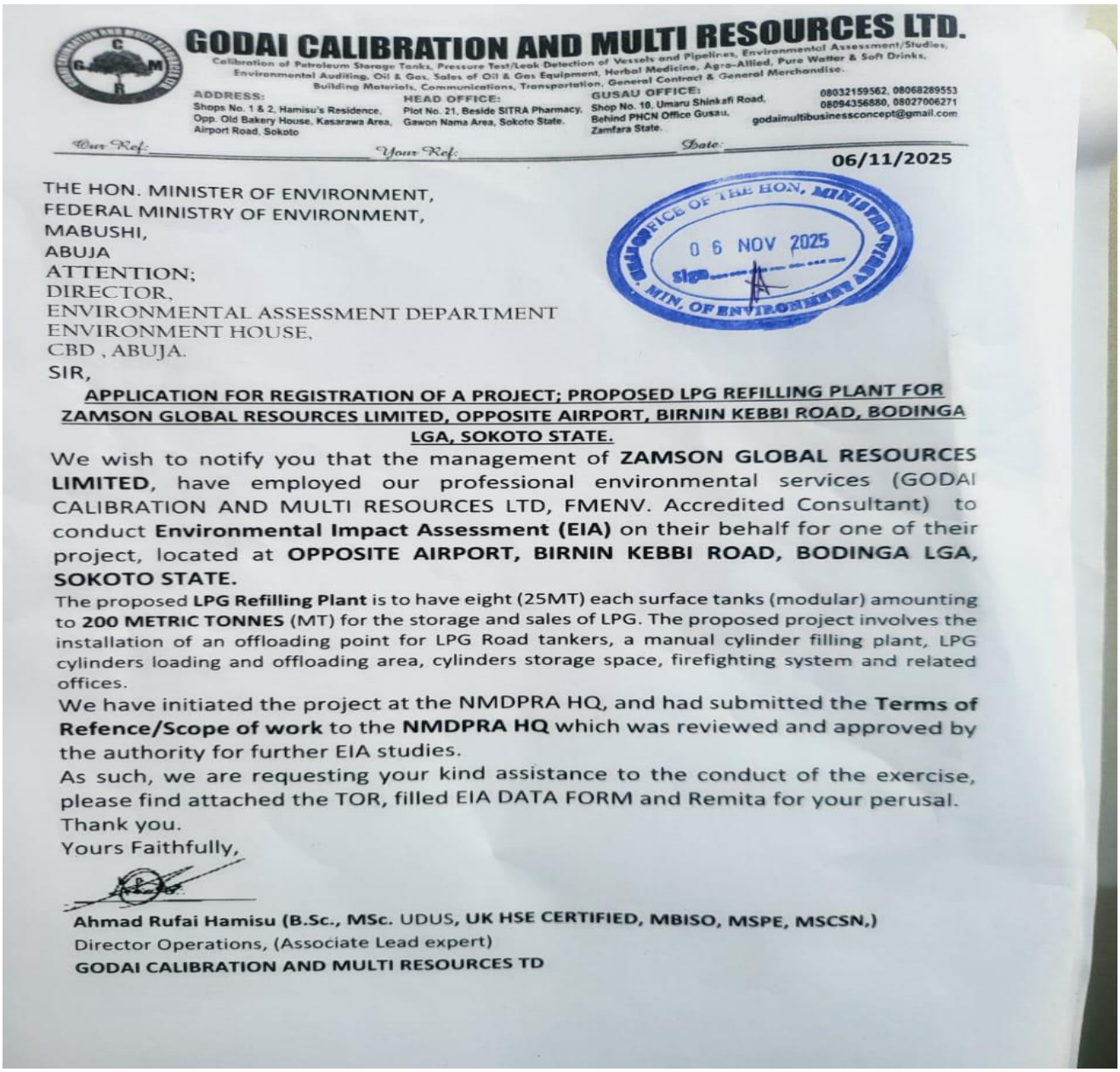
PROJECTT LOCATION:- Afa Sokoto Airport, Kebbi Road Birnin Kebbi LGA

DATE:- 19/11/2025

S/NO	NAMES	ORGANAZATION	PHONE NO	SIGN
1	A.B. Musa	[illegible]	08036129076	
2	Muhammad Abubakar	[illegible]	09035744262	
3	Bala Usman	[illegible]	08139924677	
4	Ibrahim Garba	Attendant	08147173331	
5	Dan Tunba	Attendant	09121846040	
6	Abubakar [illegible]	,,	08131549 09069108772	
7	Haliru [illegible]	,,		
8	Haruna [illegible]	,,	08132546212	
9	Abdullahi Bala	,,	09121846040	
10	Lukman Abubakar	,,	09069108772	
11	Attahiru [illegible]	,,		
12	Dandare Dandoje	,,	07069502411	
13	Abubakar Dandari	,,	08104699615	A.M.
14	Muhammad Aliyu	,,	09069108772	
15	Dan Ammar Abubakar	,,	08142610634	
16	Danyobo		07078167996	
17	Abubakar Umar	,,	08067948348	
18	Umaru Ib	,,	08067948348	
21	Sulaiman Sani	,,	08148133619	
22	Abu [illegible]	,,	08166870350	
23	Jafar Abdullahi	,,	07030480217	
24	Kasimu [illegible]	,,	08068246521	
28	Antune Aliyu	,,	09069108772	
26	Badamasi Dandoje		08037933580	
27	Saadu Aliyu	,,	07017013211	
28	Nasiru Umar		07066902020	
29	Dan Sani		08104699615	
30	Dan Galadima		08068560457	

APPENDIX III

LETTER



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Our Ref: Your Ref: Date: 06/11/2025

THE HON. MINISTER OF ENVIRONMENT,
FEDERAL MINISTRY OF ENVIRONMENT,
MABUSHI,
ABUJA
ATTENTION;
DIRECTOR,
ENVIRONMENTAL ASSESSMENT DEPARTMENT
ENVIRONMENT HOUSE,
CBD , ABUJA.

OFFICE OF THE HON. MINISTER
0 6 NOV 2025
SIGN
MIN. OF ENVIRONMENT ABUJA

SIR,

APPLICATION FOR REGISTRATION OF A PROJECT; PROPOSED LPG REFILLING PLANT FOR ZAMSON GLOBAL RESOURCES LIMITED, OPPOSITE AIRPORT, BIRNIN KEBBI ROAD, BODINGA LGA, SOKOTO STATE.

We wish to notify you that the management of **ZAMSON GLOBAL RESOURCES LIMITED**, have employed our professional environmental services (GODAI CALIBRATION AND MULTI RESOURCES LTD, FMENV. Accredited Consultant) to conduct **Environmental Impact Assessment (EIA)** on their behalf for one of their project, located at **OPPOSITE AIRPORT, BIRNIN KEBBI ROAD, BODINGA LGA, SOKOTO STATE.**

The proposed **LPG Refilling Plant** is to have eight (25MT) each surface tanks (modular) amounting to **200 METRIC TONNES** (MT) for the storage and sales of LPG. The proposed project involves the installation of an offloading point for LPG Road tankers, a manual cylinder filling plant, LPG cylinders loading and offloading area, cylinders storage space, firefighting system and related offices.

We have initiated the project at the NMDPRA HQ, and had submitted the **Terms of Refence/Scope of work** to the **NMDPRA HQ** which was reviewed and approved by the authority for further EIA studies.

As such, we are requesting your kind assistance to the conduct of the exercise, please find attached the TOR, filled EIA DATA FORM and Remita for your perusal.

Thank you.

Yours Faithfully,

Ahmad Rufai Hamisu (B.Sc., MSc. UDUS, **UK HSE CERTIFIED, MBISO, MSPE, MSCSN,)**
Director Operations, (Associate Lead expert)
GODAI CALIBRATION AND MULTI RESOURCES TD